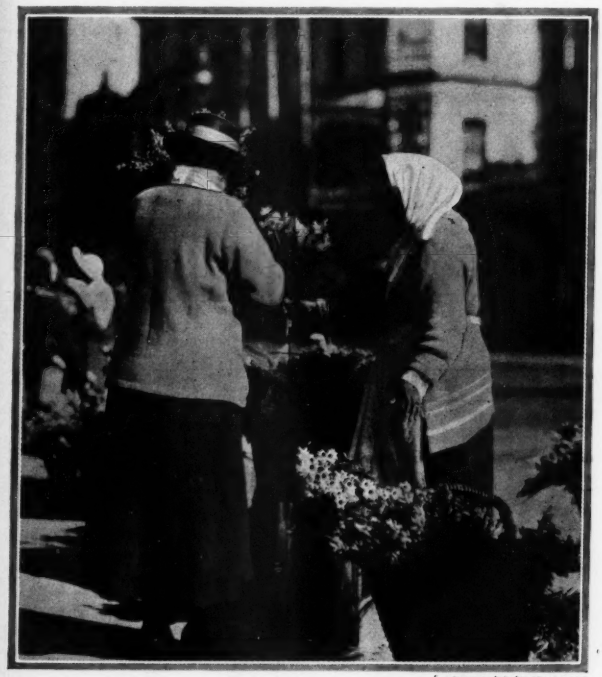
JUN 14 1926
PERIODICAL ROOM GENERAL LIBRARY UNIV. OF MICH.

DISCOVERY

A Monthly Popular Journal of Knowledge

Vol. VII. No. 78. JUNE, 1926 (Annual Subscription 12s.6d. Post Free). PRICE 1s. NET



[African State Railways

MALAY FLOWER SELLER AT CAPE TOWN.

CONTENTS

	Pages
Editorial Notes	189
The Solar Eclipse of 1926 ...	191
A Fossil Tree Trunk and What it Tells	195
What is Inhibition?	198
The Aims and Practice of Factory Ventilation... ...	204
The Cape Malays: a Moslem Survival	209
Correspondence	212
The Story of Artificial Fertilizers	213
Birds, Crops and Insects ...	215
Recent Developments in the Production of Optical Glass	217
The Month's Wireless Developments	220
Book Reviews	222

Remington PORTABLE

£2 : 2 : 0 WITH ORDER

The balance may be made by 11 monthly instalments of £1. No carriage.

CASH PRICE £12 : 10 : 0

The PORTABLE TYPEWRITER with the STANDARD KEYBOARD

One shift only for capitals, automatic ribbon reverse, and is covered by our world-service guarantee. It is so handy it can be carried and used anywhere. It has the sturdiness of all Remington machines. WRITE FOR FULL PARTICULARS 'D'

The Remington Typewriter Co., Ltd.

Head Office: 100 Gracechurch Street, London, E.C.3.

And at 4 St. Paul's Churchyard, London, E.C.4. Branches in principal Provincial Centres.

In various styles of type

PUBLICATIONS ISSUED BY THE IMPERIAL BUREAU OF ENTOMOLOGY

THE BULLETIN OF ENTOMOLOGICAL RESEARCH

(Published Quarterly)

Containing original articles on Economic Entomology (illustrated). Annual Subscription in advance, 15s. a volume, post free; separate parts 5s. each, post free. Prices of back parts on application.

THE REVIEW OF APPLIED ENTOMOLOGY

(Published Monthly)

Containing reviews of current works on Economic Entomology throughout the world. Published in two series: "A," dealing with insect pests of cultivated plants; and "B," dealing with insects conveying disease or otherwise injurious to man and animals. Annual Subscription, payable before 30th June of the current year, Series "A" 12s., Series "B" 6s., post free. Prices of back parts on application.

Separate subject indices to Series "A," Vols. i-iii, 5s. net, post free; and to Series "B," Vols. i-x, 9s. net, post free, are also published.

41 Queen's Gate, London, S.W.7

NEW BOOKS NOW READY

The Stream of Life

By Professor JULIAN S. HUXLEY. 64 pp.; imitation cloth, 1s. net.

This booklet consists of the recent Wireless talks of the distinguished scientist, revised and slightly amplified.

The Religion of an Artist

By the Hon. JOHN COLLIER. 64 pp.; imitation cloth, 1s. net.

Reflections on the Structure of the Atom

By FLORENCE M. LANGWORTHY. 272 pp. demy 8vo; cloth, 12s. 6d. net.

The author of this work deals with the subject of atomic structure from a new point of view, showing how the atoms, by the play of natural forces, must build up a universe.

Dynamics of Religion

By the Rt. Hon. J. M. ROBERTSON. Second edition, revised, with additions. 320 pp. demy 8vo; cloth, 7s. 6d. net.

Originally published under the pen-name of "M. W. Wiseman" in deference to the suggestion of certain friends, this work is now issued in its present form for the first time. By many it is regarded as one of the author's best studies. The volume, as a whole, is a fine example of heretical criticism.

A copy of "The Literary Guide," together with complete catalogue, will be sent gratis to all applicants.

London: WATTS & CO.,
JOHNSON'S COURT, FLEET STREET, E.C.4.

THREE VALUABLE BOOKS

Practical Ultra Violet Light Therapy

By T. CLYDE McKENZIE, M.R.C.S. (Eng.), L.R.C.P. (London) and A. A. KING

This handbook is intended for those medical practitioners who desire to apply Ultra Violet Light treatment in their ordinary practice. It describes in detail the mechanism of selected types of Ultra Violet Radiation lamps, with very full directions for their management and testing, followed by chapters on Dosage and treatment of diseases. The information is based upon the authors' own work and everything stated therein has been subjected to the test of both laboratory and surgery

Demy 8vo 19 Illustrations. 6/- net

Three Centuries of Chemistry

By IRVINE MASSON, M.B.E., D.Sc., F.I.C.

"There is a peculiar tang in the rare combination of learning and gaiety with which Dr. Masson writes which makes us look to him as a coming leader of scientific humanism."
—Professor Charles Singer.

Demy 8vo. Price **10s. 6d.**

Chemistry and Atomic Structure

By J. D. MAIN SMITH, Ph.D., B.Sc.

"An extremely good book . . . the best exposition of the position of chemistry in regard to Atomic Structure which we have had."—*Yorkshire Post.*

Demy 8vo. Price **12s. 6d. net.**

ERNEST BENN LTD., 8 BOUVERIE ST., E.C.4

NOW READY

ON THE ENCOURAGEMENT OF FUNDAMENTAL RESEARCH

A Report prepared by the Research Committee of the National Union of Scientific Workers

6D.

POST FREE

THE NATIONAL UNION OF SCIENTIFIC WORKERS
25, Victoria Street, London, S.W.1

ESTABLISHED 1903.

EDUCATION.

Published every Friday. *Price 2d. per copy.*

THE OFFICIAL ORGAN OF THE ASSOCIATION OF EDUCATION COMMITTEES.

EDUCATION appeals to, and is read by, the officials and members of all the Authorities and Teachers engaged in the higher and more specialized branches of the profession.

Write for Free Specimen Copy to
THE PUBLISHER,
COUNCILS AND EDUCATION PRESS, Ltd., 28, Victoria Street, London, S.W.1.

DISCOVERY

A Monthly Popular Journal of Knowledge

Vol. VII, No. 78. JUNE, 1926. PRICE 1s. NET

Trustees: Sir J. J. Thomson, O.M., F.R.S., Sir F. G. Kenyon, K.C.B., F.B.A., Professor A. C. Seward, Sc.D., F.R.S., Professor R. S. Conway, Litt.D., F.B.A.

Edited by John A. Benn.

Publishers: Benn Brothers, Ltd. All communications respecting editorial matters to be addressed to the Editor: all questions of advertisements and subscriptions to the Manager.

Offices: 8 Bouverie Street, London, E.C.4.

Telephone: City 9852 (6 lines).

Telegrams: Benbrolish, Fleet.

Annual Subscription, 12*s.* 6*d.* post free anywhere in the world. Single numbers, 1*s.* net; postage 2*d.*

Binding cases for Vol. VI, 1925, are now ready. Price 2*s.* 6*d.* net each; postage, 6*d.*

Editorial Notes.

Perhaps the most interesting scientific development occasioned by the General Strike during May was the unprecedented opportunity afforded to the science of wireless of proving its worth as an essential national service. That it was recognized early in its career as a unique force was to be concluded when the Government made wireless broadcasting and reception subject to State control, although this precaution was not thought necessary in other countries and notably in the United States. The newspapers, too, had from time to time drawn attention to wireless as damaging to their interests, an argument open to question, but one which none the less paid tribute to their new rival. The complete crippling of the Press during the past few weeks—for the single sheets that gallantly made their appearance hardly took the place of the newspapers—left wireless as the only method of communication with the public, a method of which the authorities were not slow to make full use. There was always the possibility, of course, that this channel might be interfered with by "oscillation" deliberately organized, but this did not generally occur; and a new invention is now being perfected to eliminate this nuisance, which should therefore not have to be reckoned with in the future. Although it was a matter of necessity, reflexion suggests that in the circumstances the substitute had every advantage over the orthodox channels. In the first place, news was made available to the whole country at one and the same moment, an achievement precluded to the newspapers even in cases of normal organization; more important still, information broadcast in this way could only be of greater value than that which had first to be printed and distributed, and was of the utmost consequence where the actions of thousands were affected by hour-to-hour developments. The decision of a certain trade-union, for instance, to continue work in face of general orders to the contrary, made known by wireless to men in widely separated areas at the eleventh hour, saved the country incalculable loss, while there is little doubt that the messages broadcast by the Government had much to do with the avoidance of undesirable incidents by either party to the dispute. The extent to which the public appreciated these emergency arrangements for being kept informed of current happenings was indicated in an exceptional rush to buy wireless installations of any obtainable type.

* * * *

Following the Prime Minister's address on the eve of the crisis, the suggestion of government by wireless was made in *The Spectator*. "In each village and town and city," a correspondent wrote, "would be set up loud-speakers in central squares, or convenient halls, to which citizens should be called by a pre-arranged signal, and from this mighty tribune, like the orators and philosophers of Rome and Athens, the accredited head of the people should put before his millions of listeners a clear and reasonable statement of the national difficulties of the moment and ask for the great patience that is required in dealing with such difficult subjects by friendly negotiation." A sense of the ridiculous can hardly fail to accompany this picture of an assemblage of citizens before the modern oracle, able to approve but as unable to affect its edicts as were their humble prototypes at Delphi; but this is surely none other than that which happened during the past few weeks, when addresses were heard in thousands of homes. Broadcasting in this

country has hitherto been confined to subjects of a non-political character, with the single exception of addresses by the party leaders at the general election of 1924, but meanwhile in America certain political interests are contemplating a wireless electioneering campaign. The ostensible reason for this departure is that "the soap-box orator can no longer attract the attention of the public because of the large number of radios," but actually several persons mentioned as being likely to speak by this method are at present unable to find a platform, and it is difficult to see why it is assumed they could do so with the aid of the wireless. At any rate they would be saved the humiliation of realizing that no one was listening to them!

* * * * *

The discovery of a means of eliminating the oscillation nuisance, which is undoubtedly at present one of the greatest barriers to satisfactory wireless reception, is the result of research by Sir Oliver Lodge, and it is a matter of singular interest that the device may be available to listeners during the year in which the British Association again meets at Oxford. For it was at the last meeting there, in 1894, that Sir Oliver gave the first public demonstration of wireless telegraphy, in illustrating the reception of Morse signals by the long and short deflexions of a Thomson marine-signalling galvanometer over a distance of some hundreds of yards. Few could have foreseen or would have dared to prophesy the remarkable developments of the thirty years since that momentous experiment, and it will be a lasting tribute to British endeavour that the veteran scientist, who might well have been satisfied to leave details to others, should himself have succeeded in perfecting a process that he was among the first to put into practice. As to how far Sir Oliver Lodge was at the time aware of the significance of his early research is known to himself alone; but this is likely to be disclosed very shortly, as arrangements have been made with Sir Oliver Lodge to publish his reminiscences of that memorable occasion in the August number of *Discovery*. The unusual interest attaching to this year's meeting of the Association at Oxford, as marking thirty years since the first demonstration of wireless was given there under its auspices, will thus find permanent record in this journal, of which the August number will be specially devoted to the British Association. In addition to this important article, which is certain to attract world-wide interest, the issue will contain a number of other exclusive features, and to commemorate the occasion, copies will be presented to the several thousand members attending the meeting, which takes place from 4th to 11th August.

A similar arrangement has been made in connexion with the third congress of the universities of the Empire, to be held in July, when some hundreds of visitors from all parts of the Dominions will assemble in Cambridge. The July *Discovery* will be an Empire University Number, through the medium of which the Colonial Secretary, the Rt. Hon. L. S. Amery, M.P., has consented to express a message of welcome to the delegates.

* * * * *

Mention was recently made in these columns to the growing interest being taken in the life and institutions of the past, and not least is this illustrated by curiosity in objects hitherto regarded as commonplace. Decoration, of course, has long been the subject of research, but this has now extended to every detail of the art, and "A History of English Wall-paper" (Batsford, 63*s*.) has just been written by Messrs. Sugden and Edmondson. This is noticed in *The Cambridge Review* over initials that betray the writer as the Master of Christ's College, in whose Lodge the earliest decorated paper was discovered during restoration some ten years ago. Wallpapers did not come into common use until the time of Queen Anne, when they largely replaced tapestries and panelling. "One of the most interesting developments," writes "A. E. S." in the article referred to, "was the arrival of Chinese papers and later their English imitations. They generally represent landscapes with foliage, birds and butterflies, or they depict the customs and occupation of the people. A set of these comprised twenty-five sheets four feet wide and twelve feet long. Though they were not 'repeats' various strips when joined together covered a wall and presented a more or less complete design, the branches of trees, for instance, spreading from one strip to its neighbour. Such a set formed a useful wedding present and was frequently given. These papers first found their way to England in the 17th century, and were dealt with not only by the merchants and brokers in Mincing Lane and Birchin Lane, but by the tea dealers and toy sellers who imported them with other goods. The invention of paper seems to have been due to the Chinese, who in the reign of Ts-ai Lun, A.D. 105, are credited with inventing rice straw paper. Some of these old Chinese papers have lasted till the present day, and I well remember in the end of the last century stopping at a house in Edinburgh where the bedrooms were all decorated with these beautiful hangings."

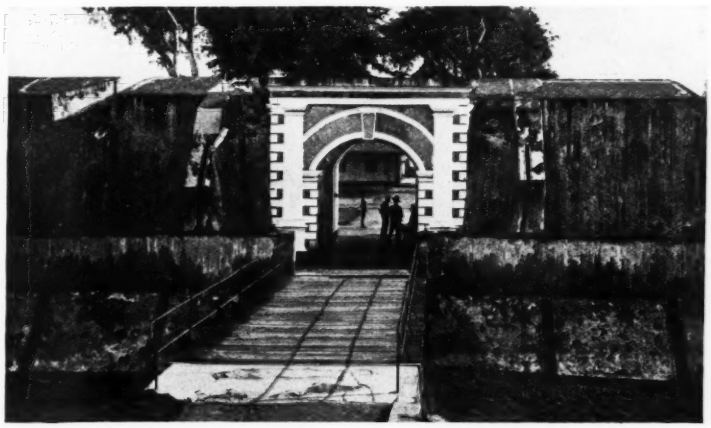
The Solar Eclipse of 1926.

By Lt.-Col. F. J. M. Stratton, M.A., D.S.O.

During last winter a party of British astronomers travelled to Sumatra to observe the solar eclipse visible there in January. The author, who took part in the expedition, discusses the significance of the eclipse and how the work of making records was carried out.

For the first time for over two hundred years a total eclipse of the sun is to be visible in England and Wales in the early morning of 29th June, 1927. Those who have a clear eastern horizon may for some twenty-three seconds see a phenomenon that astronomers generally have to travel thousands of miles to observe. The time is early in the morning—about 5 h. 23 m. Greenwich mean time, or 4 h. 23 m. a.m. summer time. The zone of totality is a belt some thirty miles wide with a central line passing by Criccieth, Colwyn Bay, Southport, Settle, Richmond Darlington and Hartlepool.

Though the spectacle with which the fortunate will be rewarded is shorn of the terrors that used to accompany it, though there is no longer need for drums, shouting and fireworks to drive away the dragon which is swallowing up the sun, the wonder and the beauty remain for all to share. It is only for about two hours all told that the eclipsed sun has been on view during the last fifty years, and it is pretty safe to say that no single observer has seen it for more than twenty minutes, and then probably only if he has travelled some 80,000 miles on eclipse expeditions.



FORT MARLBOROUGH, AT BENKOELEN, SUMATRA,
where the British astronomers made their headquarters for observing the eclipse in January last.

Over forty astronomers assembled last winter in the island of Sumatra, coming from Europe, the United States, Australia, and the neighbouring island of Java, to see the total eclipse of 14th January, 1926. Luckily, as it turned out, the majority of the expeditions chose for their camps the former British settlement of Benkoelen, once the headquarters of the great Sir Stamford Raffles; luckily, too, the British party chose for the site of their eclipse camp the old British fort—Fort Marlborough—specially offered to them by the Dutch authorities. Benkoelen offered the best weather on the vital day to the observers, and Fort Marlborough secured the clearest patch in a somewhat cloudy sky for the British expedition. The whole 190 seconds of totality were clear of haze and cloud for the British expedition alone of all the parties assembled in Sumatra, though the Italian expedition to Jubaland in East Africa were also fortunate in their weather.

It may well be asked on what grounds astronomers justify the expenditure of money and time entailed in an eclipse expedition to distant countries when the time of observation possible is so short and the prospect of fine weather so uncertain. A first answer is that the radiation from the sun plays so important a part in our lives that we cannot afford to neglect any opportunity of examining the outer envelope of the sun, and this can only be seen when the direct bright light from the sun's disc is cut off from our atmosphere by the intervening moon. A second and more complete answer lies in the fact that in this envelope or upper atmosphere of the sun Nature is carrying out certain experiments on the behaviour of atoms under conditions of temperature and pressure such as we have not yet learnt to reproduce in the laboratory; and from a study of these experiments there is much to be learnt about radiation from an atom and about atomic structure.

The problems with which the British and Australian expeditions were chiefly concerned at this eclipse were the distribution in the upper layers of the sun's

atmosphere of different elements and of atoms of differing structure of the same element. The problem of the nature of the corona was not overlooked. Direct photographs to show what shape it had on this occasion were taken as a contribution to the discussion, for which material is steadily accruing, of the various forms which the corona assumes, and of the connections between the corona, prominences and sunspots. Also spectrograms of the corona were taken to improve the accuracy with which the wave-lengths of the lines of its spectrum are known; results from these plates should in time aid the search for the elements composing the corona. The Einstein problem—the apparent displacement of stars near the sun owing

THE AUTHOR ADJUSTING THE POLAR AXIS OF A COELOSTAT.

to the bending of the rays of light from them as the rays passed through the sun's gravitational field—was not tackled by the British, though the German and American expeditions were both occupied with it. For us the confirmation of the result that Einstein had predicted was secured by the British expedition (Dr. A. C. D. Crommellin and Mr. C. R. Davidson) to Sobral in Brazil in 1919. With the less favourable field of stars round the sun presented by the eclipse of 14th January last, no useful purpose could be served by repeating the programme of 1919, unless new instruments were available likely to give results of a higher order of accuracy. Money for such instruments was not available, and British astronomy will remain content with the results secured in 1919, unless or until doubt should be thrown on them by later observers. The chief object of the British party on this occasion was a spectroscopic examination of all layers in the sun above the reversing layer, the layer which gives the absorption lines of the Fraunhofer spectrum.

The Apparatus Employed.

The instruments taken to Sumatra included two slit spectroscopes and two objective prism cameras. The slit spectroscopes, loaned by the Solar Physics Observatory, Cambridge University, were both formerly the property of the late Colonel Grove-Hills, and had both been used at eclipses by him and others in former years. One of them, with prisms of flint glass, was used with plates stained with dicyanin to extend the known range of the coronal and flash spectra farther into the infra-red. The other, with prisms of quartz, was similarly employed to extend the known range in the region of shorter wave-lengths in the extreme ultra-violet. As mirrors of silver or glass would not reflect these rays, it was necessary to use speculum mirrors to form the image of the sun on the slit of this spectroscope. In addition two objective-prism cameras were used for intermediate regions of the spectrum. For one of these a camera of forty-foot focal length was employed; the tube of this camera was made for the eclipse of 1905, and had lain unused since then. For the other camera, of twenty-foot focal length, a tube was improvised from old apparatus used at the eclipses of 1919 and 1922. These telescopes of great focal length were employed to secure large-scale spectra. For them, as for the slit spectroscopes, it was necessary to use coelostats, mirrors rotating round the polar axis in such a way as to reflect the beam from a given object in the sky in a constant direction. For convenience of handling it was decided to have the two long camera tubes horizontal and parallel. For this programme the original expedition of two was quite insufficient, but a party of volunteer observers who travelled out from England at their own expense and shared in the work of the expedition made the extensive programme possible. This party consisted of Dr. F. W. Aston, Colonel Waley Cohen, Major R. Davies and Mr. G. E. Barton, the last-named bringing his own photometric and cinema-photographic apparatus.

The first task on arrival at the eclipse camp was to determine the north and south line, to plan out the camp, and to give instructions to the native masons for the erection of pillars of masonry on which the instruments could be stably supported. The pillars were made of coral rock and mortar faced with a kind of cement. Without much knowledge of the Malay

language it was quite easy to give the necessary instructions to the head mason by signs; he had as his measure a ruler with inches on one side and centimetres on the other, and was perfectly competent with its aid to carry out our instructions without error. The pillars were left behind in the fort when it was evacuated by the expedition, and some of them probably still remain as mementoes of the eclipse. They may now serve the native police, who live in barracks in the fort, as part of a jumping or leapfrog course for physical training. After the pillars were completed, and before the instruments were mounted on them, they served as a sleeping-ground and place of refuge for numerous cats.

While the pillars were being built the heavy baggage was being unpacked, the dark room established in one of the dungeons in the rampart of the fort, and the camera tubes and frame huts fitted together. Palm-leaf shelters of atap were also built over the pillars and instruments as a protection against both sun and heavy tropical rainfall. The native carpenters, indeed the whole population of the camp, took great interest in the work of preparation, particularly in building up the sectional iron framework of the forty-foot tube. They also found much to interest them in the sunspots shown on images of the sun, which they were allowed to examine through the instruments, and in the bright-coloured spectral bands thrown on ground glass plates by the objective prism cameras.

The adjustment of the coelostats so that their axes were parallel to the polar axis of the earth, and the mounting and adjustment of the clocks and the spectroscopes, were the next items of work to be done. Then came the task of focussing the lenses and mirrors. Finally, two days before the eclipse, the silvered mirrors to be used in the eclipse were brought out and mounted in their cells in the coelostats. Two

ASTRONOMICAL APPARATUS USED BY THE EXPEDITION, erected under palm-leaf shelters in the camp at Fort Marlborough.

DR. ASTON GETTING READY TO TAKE OBSERVATIONS.

days before the eclipse the expedition was ready; it had taken nearly a month after arrival to complete the preparations and not too much margin had been allowed for delays. All was ready in time for the eclipse itself.

Dress Rehearsals.

Dress rehearsals were held on the two days preceding the eclipse—a most necessary and useful precaution. An eclipse lasts so short a time that there is no opportunity of making good any mistakes made by the observers, and the better drilled a party is the better chance there is of success in carrying out the programme during the actual eclipse. Another occupation that took up considerable time in the last few days was the escorting round the camp of local residents, who were naturally interested in our preparations and to whom we were indebted for many acts of courtesy. Still another important thing to be done just before the eclipse was to lecture to the native police on the eclipse and on the various instruments. This was done with the help of Captain Akkersdyk, the officer commanding the police, who acted as interpreter and had the greater part of the work to do in answering the somewhat incredulous questions of the natives. The chief work of preparing the Malays for the phenomena of the eclipse was done by means of cards containing an account and explanation of the eclipse in the Malay language, and distributed freely to the children attending the native schools. These cards had a central hole covered by a small piece of blackened cinema film through which the partial phases of the eclipse could be observed without danger to the eyes. It is to be hoped that some steps will be taken in this country by the education authorities before the eclipse of next year, both to rouse the interest of the school children in the eclipse, and to protect them from damaging their eyes through looking directly at the partially-eclipsed sun.

The day of the eclipse broke fine but cloudy, as was normal at Benkoelen. During the morning the sky cleared, but never completely; there were always clouds about, particularly towards the hills in the north-east. The fort was strangely silent, all the women and children being ordered out of it some hours before the eclipse. The arrival of a succession of telegrams bringing good wishes for our success alone broke the quiet of the final stages of preparation. When the first notch was made in the sun's disc the sun was riding high in a clear sky, but there were still clouds about and during the hour between first contact and the commencement of totality the sun was more than once completely covered with clouds. Not till shortly before totality did the sun break clear from the clouds, and ten minutes after totality it was once again hidden. The thrill of uncertainty was maintained to the last and the relief at the end of totality, during which the sun had remained clear throughout, was immense. All the observers were able at some time or other during their longer exposures to take a glimpse of the eclipsed sun itself. I was only free to take a short glance, but the picture remains vividly in my mind. In a dark sky, such as is seen on a bright moonlight night, a few stars were to be seen, but attention was riveted on the sun itself. The black disc of the moon, fringed with the red flames of the solar prominences, was surrounded by a pearl-grey envelope with rays shooting out irregularly in various directions—the corona. It is a sight not easily forgotten, but only a few seconds could be spared for it, as the real value of the expedition lay in the photographs that were being secured by the instruments, and the latter had chief claims on our attention. The only observing incident that need be recorded here is the piece of very bad luck that befell Mr. Barton. In a reel of tape which was passing over a small flame to be smoked, preparatory to having time and observing signals scratched on it, a maker's flaw reached the flame just as totality commenced. The tape caught fire and completely spoilt the most important and interesting part of Mr. Barton's observations. Otherwise the complete set of plates which it had been intended to secure were obtained and were developed during the next few nights. Ice was used to keep down the temperature of the developer and Mr. Davidson's experience and skill completely saved us from misfortune at this stage, such as has befallen more than one eclipse expedition to tropical climes. Months of work on the plates have to be done before the full value of the results can be made known, but it may suffice to say here that a preliminary study of the plates shows that they are amply good enough to justify such work—nay more, it can be confidently stated that they will justify the time spent in preparation for the eclipse, the time and money spent in the expedition itself, and the further time to be spent in working out the results that they contain.

Successful Polar Flights.

THE American and Swedish airmen who set out last month to fly across the Arctic regions are believed to have been successful in reaching the North Pole, and one of them, Commander Bryd, now proposes to make a similar Antarctic flight. According to accounts received, *The Times* reports, he navigated his aeroplane on 9th May from Spitsbergen to the Pole and back in 15½ hours. Whether this goal was actually reached or not, however, the real value of his achievement consists in the meteorological reports which he will be able to furnish on these unknown regions. The same may be said of Captain Amundsen's seventy-two hour flight in the "Norge" from King's Bay across the Pole to Teller in Alaska, during which no land is understood to have been discovered between the North Pole, where considerable time was spent in taking observations at a height of 600 feet, and Point Barrow.

A Primitive Copper Industry.

AMONG papers of interest read at a recent Glasgow meeting of the Institute of Metals was one by G. B. Phillips, B.A., of Philadelphia, U.S.A. It stated that the account of the use of copper in pre-Columbian America as given by the old Spanish writers being considered "meagre and vague," the author has endeavoured to obtain more accurate information by an examination and analysis of the copper specimens found in museums. He advances practical evidence of the existence of a pre-historic copper industry in America, carried on by aborigines, who made widespread use of copper for tools, weapons, implements, ornaments, and ceremonial objects. This extensive manufacture of copper implements of similar shape to take the place of the stone and bone articles formerly used—indicating a familiarity with the metal, and an appreciation of its advantages—would seem to justify the claim of a primitive copper culture for the American Indians, suddenly interrupted by the arrival of the Spaniards and the knowledge of the greater advantages of the use of iron and the terribly destructive weapons made of that metal.

A Fossil Tree Trunk and What it Tells.

By F. J. North, D.Sc., F.G.S.

Department of Geology, National Museum of Wales.

Interesting evidence as to the conditions under which coal accumulated is afforded by fossil tree trunks discovered from time to time. The author was able to examine before its removal a specimen found last year in a deep coal seam in South Wales and discusses its bearing on the problem.

COAL undoubtedly represents the debris of ancient forests, but authorities are by no means agreed as to the precise conditions under which the material accumulated. Some hold that it drifted into lakes or lagoons where it sunk and accumulated like any other sedimentary rock; others maintain that the decaying vegetable material accumulated on the site of the forest itself, and that the rock beneath the seam represents the soil onwhich the trees grew. In the latter case the preservation of the coal substance is the result of subsidence which allowed water to encroach upon the site of the forest, killing the trees and burying the remains beneath sand and mud.[1]

The rock or underclay beneath many coal seams is often crowded with roots which may or may not be attached to the bases of tree trunks. The clay itself consists principally of silica and alumina; it is deficient in alkalies such as potash, and has been considered as representing an old exhausted soil. Incidentally, it is the low percentage of alkali present in it which makes the underclay less liable than ordinary clay to soften when strongly heated, on which account it is called fireclay, and is used for making firebricks and for lining ovens.

While, in a chemical sense, the underclays may resemble soils exhausted of their soluble salts by long cultivation, mechanically most of them are not at all like ordinary soils, but are more like the muds which occur in modern tropical swamp-forests. In such muds the stumps and roots of growing trees occur, together with others that may have drifted into their present position.

FIG. 1.
A SWAMPY FOREST OF THE COAL PERIOD, AS SUGGESTED BY FOSSIL PLANTS FOUND IN COAL SEAMS.
Right.—The tall branching *Lepidodendron*, allied to the modern club mosses.
Centre.—*Sigillaria*, with straight stout stem.
Foreground—Reed-like *Calamites*, of same plant-group as modern horsetails.

There are grounds for believing that many of the trees which provided the material of coal seams grew under swampy conditions, and the probable appearance of one of the coal forests is indicated in Figure 1, which is a restoration based upon the fossil plants found in the Coal Measures.

If the evidence regarding the conditions in a coal forest has been correctly interpreted, there is no reason why erect stumps rooted on the site of growth should not occur in the coal-bearing strata — the roots being in the underclay, and the trunk projecting upwards into the coal, perhaps also into the shale above; and it seems reasonable to assume that any tree trunk, especially if the roots are attached, is in its natural position, thus giving support to the suggestion that the material of coal seams accumulated *in situ*. It does not, however, necessarily follow that every erect trunk found in the coal-bearing strata is in the position it occupied when growing. This was certainly not the case with a trunk recently found in the Deep Navigation Colliery at Treharris in Glamorgan.

A "fault" or displacement of the strata had affected the Six-feet Seam, lowering it for a distance afterwards proved to be about forty-three feet, and as a drift or inclined tunnel was being driven through the disturbed ground in search of the continuation of the seam, a mass of stone reproducing the exact form of the trunk of a tree was revealed, rising through the floor of the drift, and disappearing into its roof (see Figure 3). The workmen, realizing the importance of their discovery, reported it to the management, and the

[1] See list of references at conclusion.

writer was given an opportunity of examining the tree in position.

The information so obtained adds much to the interest of the fossil, for if such a specimen is to throw any light upon the physical conditions of the time when it was a living tree, it is necessary to know its precise relation to the strata in which it is now embedded, information not usually to be gained from an examination of the specimen after it has been brought to the surface.

FIG. 2.
PART OF TRUNK
of fossil tree, *Sigillaria*, found at Treharris, Glamorgan.

Further excavation revealed a length of about fifteen feet of a trunk which was ten inches in diameter at the top, thickening to eighteen inches near the base, where it expanded very rapidly to thirty-three inches. Unfortunately, as is usually the case near faults, the rock was very much shattered, and it was impossible to remove the whole of the exposed fossil, but a section five feet six inches in length has been preserved. As the fossil was situated in a narrow drift, 2,350 feet beneath the surface, and about three miles from the pit's mouth, its removal was a difficult task, especially as Coal Measure shales always tend to disintegrate on exposure to the air. It was, however, very successfully accomplished by the workmen who discovered the tree, and on arrival at the museum in the case of sheet iron that was erected around the fossil before it was dislodged, none of the fragments were displaced, and the trunk was reconstructed in the geological exhibition gallery, as a gift from the Ocean Coal Company, in whose colliery it was found (see Figure 2).

Surface Markings.

The surface markings of the tree have been partly obliterated during the process of fossilization, and it is not possible to determine with certainty the species to which it belongs; there are, however, distinct traces of vertically arranged leaf-scars indicating that it is a member of the genus *Sigillaria*. *Sigillaria* was a tree of the coal forest period with a tall straight stem on which the leaf scars were arranged in vertical rows, giving a characteristic ribbed appearance to the fossil remains of its trunk, even when the outer layers have not been preserved (see Figure 5). Although found in an erect position, the trunk was not in the position it occupied when growing, because it was truncated both above and below, and was entirely without roots; and it may be of interest to inquire how a drifted trunk could assume an erect position.

A tree growing by the water's edge may, in time, have so much of the soil about its roots washed away that it falls into the water, where it dies and is shorn of its branches. The trunk of a sigillarian tree had a large central pithy region, surrounded by a relatively thin layer of wood, and such a trunk lying in the water would soon become partially hollowed out by the decay of the soft material. If eventually it drifted into deeper water such as that of a lake, it might well assume an erect position, because if the roots were still attached they would hold entangled a considerable weight of soil, or, even if the trunk had been broken off and was rootless, its centre of gravity would still be low on account of its greatly expanded base. After drifting for a time, the tree would eventually sink to the bottom and become enveloped in mud—an erect trunk not in the position of growth. To have drifted thus a tree must have been growing near the

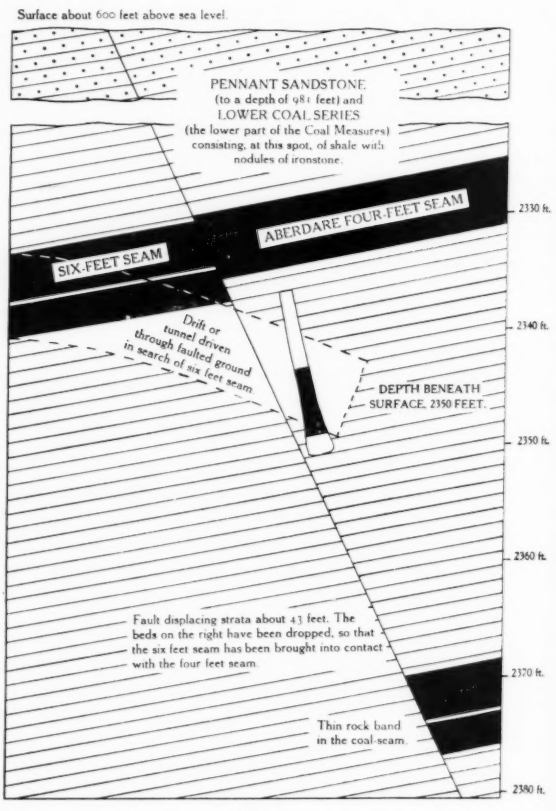

Surface about 600 feet above sea level.
PENNANT SANDSTONE
(to a depth of 981 feet) and
LOWER COAL SERIES
(the lower part of the Coal Measures)
consisting, at this spot, of shale with nodules of ironstone.
ABERDARE FOUR-FEET SEAM
SIX-FEET SEAM
Drift or tunnel driven through faulted ground in search of six feet seam.
DEPTH BENEATH SURFACE, 2350 FEET.
Fault displacing strata about 43 feet. The beds on the right have been dropped, so that the six feet seam has been brought into contact with the four feet seam.
Thin rock band in the coal-seam.
2330 ft.
2340 ft.
2350 ft.
2360 ft.
2370 ft.
2380 ft.

FIG. 3.
DIAGRAM ILLUSTRATING POSITION IN THE EARTH'S CRUST OF THE FOSSIL TREE FOUND IN COAL MINE AT TREHARRIS, 1925.

FIG. 4.
TWO STEMS OF *SIGILLARIA* AS FOUND AT CWM LLECH, SOUTH WALES.
From an illustration in the Report of the Swansea Philosophical and Literary Institution, 1838.

water's edge, and the Treharris trunk confirms the conclusion arrived at by those who have studied the cell-structure of *Sigillaria* and its associates, which is, that the tree favoured wet and muddy soils and was most at home in the swampy regions of the Coal Forests.[2]

From the nature of the trunk and the manner in which it has been preserved it will be realized that the fossil is not the actual trunk of a Coal Measure tree. The hollow interior of the dead trunk was filled with sandy mud, and the relatively thin ring of woody tissue has been converted into a much thinner layer of coal. It is this coaly layer that has separated the sediment inside the trunk from that outside, making it possible to remove the fossil from the matrix in which it was embedded.

Occasionally erect fossil trunks are found under conditions that leave no room for doubt that they are in the position in which they grew. Some such were found in South Wales about ninety years ago by Mr. (afterwards Sir) W. E. Logan, who was engaged in a geological survey of the district. They occurred in the rock forming the sides of a deep-wooded glen, Cwm Llech, near the head of the Swansea Valley, and in the words of the report describing the discovery "had their lower extremities buried in a bed of shale" from which they extended upwards into the overlying sandstone. Two of the trunks which appear to spring from one root are illustrated in Figure 4, which is copied from a drawing in the third annual report of the Swansea Philosophical and Literary Institution (1838). They were excavated by Mr. (afterwards Sir Henry) de la Beche, and removed to the Royal Institution at Swansea, in the grounds of which they now stand. There were indications of so many trunks at this locality that the report continues "it is not extravagant to imagine, that were the sides of the dell . . . cleared away, a whole primaeval forest of those gigantic Segillaria [*sic*], standing as they grew, would be exhibited to the wondering eyes of the beholder."

Such a clearance was actually effected in Victoria Park, Glasgow, resulting in the exposure of a number of tree stumps with roots attached.[3] They clearly indicate the site of an ancient forest which, however, existed at a slightly earlier period than most of

FIG. 5.
SURFACE OF PART OF THE TRUNK OF *SIGILLARIA*, WITH ITS VERTICALLY-ARRANGED LEAF-SCARS.
From a specimen in the National Museum of Wales.

those which provided the material for the coal of north-western Europe. A similar forest was discovered in the neighbourhood of Saarbrücken in Germany, but in most cases where erect trunks have been discovered, careful examination has revealed the fact that they had drifted into their present position, and cannot therefore be used as evidence in a discussion as to the conditions under which the coal substance accumulated. This, however, in no way detracts from their interest, because of the light they throw upon the form and habitat of some of the Coal Measure trees.

BIBLIOGRAPHY.

(1) " The Natural History of Coal." E. A. N. Arber (1911).

(2) " The Ecology of the Westphalian and the Lower Part of the Staffordian Series." D. Davies. *Quart. Journ. Geological Society.* Vol. 77 (1921), pp. 30-74.

(3) " Fossil Plants." A. C. Seward. Vol. I (1898) frontispiece.

What is Inhibition ?

By Professor D. Fraser Harris, M.D., D.Sc.

The old saying that " it is not hard work but worry that kills " is a popular recognition of the vital part played by one form of inhibition—the emotional. A clear conception of the meaning of inhibition, which Professor Harris discusses, is essential to a knowledge of the important science of psycho-analysis.

THE term " inhibition " is one frequently met with at the present day. It is used by physiologists and psychologists as often as any other of their technical terms. By " inhibition," the biologist understands the restraining, quelling or stopping of the vital activity or " function " of an organ or tissue.

The lawyers employ the word in the same sense, meaning to interdict, prevent or restrain.

The biochemists often use the term when describing the actions of agents on one another. Thus a chemist will say that the presence of an alkali in the stomach " inhibits " the activity of the pepsin of the gastric juice ; he means no more than that, as it tends to neutralize the hydrochloric acid, the adjuvant of the ferment, the latter will act less efficiently ; there will be an apparent restraining of the solvent power of the pepsin. This kind of inhibition can go in a glass vessel, and in that sense there is nothing " vital " about it.

Similarly when he speaks of the " inhibiting action of a negative catalyst " he merely means that that catalyst retards the velocity of the reaction in question instead of accelerating it like a positive catalyst. This is not one of the vital inhibitions we are about to study. In this sense you could speak of any source of friction, for instance, inhibiting a sliding movement ; this is not physiological inhibition.

We presume that everyone knows that the physiologist assumes some condition of a tissue as *normal*, that is of such a degree of excitability that it can by appropriate means (stimuli) be augmented on the one hand or quelled on the other.

Now true physiological inhibition or restraint must at the outset be sharply distinguished from the diminution of protoplasmic activity through devitalizing agencies. Thus chloroform and certain of the poisons diminish the efficiency of the heart ; and some writers would speak of the heart as " inhibited " by chloroform and those other drugs.

Ambiguous Terms.

But this use of the term is open to objection ; for although the action of the heart is depressed, it is so by being poisoned ; and we would speak rather of the atonic, toxic or devitalizing action of the chloroform. In other words, every case of diminished activity is not one of inhibition ; activity may be quelled either by damaging the underlying mechanism or quelled by the application of a brake ; only the latter is real inhibition. In German, this difference is expressed by the words Lähmung and Hemmung respectively ; Lähmung meaning to disable or paralyse, Hemmung to restrain or inhibit.

Again, mere diminution of vitality is not inhibition ; as we grow older our vitality is diminishing, but nothing is being truly restrained ; we have simply less energy for living. Inhibition is typically seen in the young active person voluntarily restraining some exhibition of physical or mental violence.

Clearly restraint can be exerted either in the sphere of the psychical or in that of the physical : we can restrain our " tempers " and we can retard our rate of walking ; technically we are inhibiting emotion in the former instance, and co-ordinated neuro-muscular activities in the latter.

It follows then that there must be three great classes of inhibition :—

1. Psychic inhibitions of psychic states ;
2. Psychic inhibitions of physiological states ; and
3. Physiological inhibitions of physiological states.

Types 2 and 3 we may call intra-neural inhibitions. In the present study little account will be taken of

the inhibition of psychical states on one another—large and important as the subject is and full of interest for the practical psychologist.

Type 1. We may, however, note that purely psychic inhibitions may be either consciously or subconsciously exerted.

The Essence of Character.

The training and strengthening of the conscious or voluntary inhibitions is of the essence of character-building, for these are almost always inhibitions of emotional states; the latter, the sub-conscious, are being extensively studied in "psycho-analysis."

The inhibitory influence of sub-conscious states on one's mental life is of the utmost practical importance for mental health and comfort. To discover one of these inhibiting sub-conscious states which is bringing misery into the life of an individual and to exorcise it is a practical service of the highest value.

Psychological medicine has been enriched by the conception of the inhibitory power of the sub-conscious state.

Type 2. But psychic states may inhibit physiological activities; and this kind of inhibition may be either voluntary or involuntary.

When I will to hold my breath, I am inhibiting voluntarily the neuro-muscular mechanism of respiration; and although I do not know *how* this comes about, the restraint is a fact: I can restrain the rate of breathing, just as I can my walking, whenever I wish to.

The actual spot in the nervous system which is being inhibited is the respiratory centre itself, one of the many centres in the medulla oblongata.

It is interesting to remember that there is a very definite limit to the time during which the breath can thus be held. After a short time we are forced to begin breathing again: this is called the "breaking point"; beyond it we have no volitional control. There are relatively few bodily activities with which we can voluntarily interfere after this fashion.

The much commoner form of psychic inhibition of a physiological event is the emotional; this is always involuntary. Just as pleasurable emotions can accelerate the heart's action or increase the efficiency of digestion, etc., so, conversely, can depressing emotions inhibit the heart and impair the digestion.

An emotional state can take the breath away completely for a few seconds; "Laugh and grow fat," and, "It is not hard work but worry that kills," are the popular recognition of these things.

Here, too, it is on centres in the central nervous system that the inhibitory influences descend. A centre is a group of nerve-cells specialized to preside over some function: the respiratory centre controls the rate and depth of breathing; the vascular centre maintains the calibre of the contractile blood-vessels at a relatively small size; the centres for muscular action keep the body-muscles in a state of "tone."

Nerve-fibres passing from those centres to the tissues and organs are said to "innervate" these. Such centres are "tonic" centres, or constantly in action, and are responsible for the maintenance of some activity at the periphery—the contraction of blood-vessels—or the tone of muscles, and so forth.

Clearly the inhibition of these centres would result in the function over which they preside being less perfectly performed. If the centre for the control of the calibre of blood-vessels be inhibited, the blood-vessels will dilate; if the centres for the maintenance of the tone of the muscles be inhibited, the muscles will become relaxed.

All centres, however, are not designed to maintain the tone of a tissue or organ, but on the contrary are actually specialized to inhibit it. They are, in fact, the specifically inhibitory centres—a discovery which is one of the most interesting things in the physiology of the nervous system. The best known of such centres is that giving rise to the nerve which on stimulation slows or stops the heart. Now if this inhibitory centre be *stimulated*, the result will be inhibition of the heart; but if the centre itself be *inhibited* the result will be an increased action of the heart, because the heart is also under the simultaneous influence of another nerve whose functions are augmentor. This is, in passing, an example of double or antagonistic innervation. It should be clearly understood that the energy for the beating of the heart is inherent in the heart and not conferred on it by the augmentor nerve.

A Practical Analogy.

An analogy may be helpful (Fig. 1). Let us suppose a boy is deputed to restrain a dog from running away by holding it back with a leash: the dog is striving to be off but the boy holds it in. The dog answers to the heart tending to beat fast and strong, the boy is the inhibitory centre A and the leash is the inhibitory nerve B.

If now the boy is encouraged (stimulated) to hold the dog in, he will do so more effectively, and the dog's tendency to run off is restrained; if, however, the boy is *restrained* from pulling so hard (inhibited), the dog will tend to escape and may run off altogether. The inhibition of an inhibitory centre therefore results in an increase of the action which the centre is designed

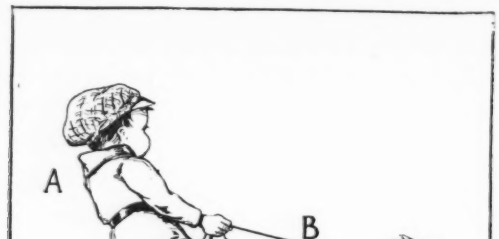


FIG. 1.
BOY HOLDING IN A DOG ON A LEASH,
representing A, the inhibitory centre, and B, the inhibitory nerve.

to restrain. In the intact body the psychic stimulation or the inhibition of a centre, such as over the path D in Fig. 2, is almost always emotional in origin.

We might note here that this same boy will also serve to illustrate the difference between true inhibition and devitalization. When you restrain the boy by any (legitimate) means in the example just given, *that* answers to legitimate inhibition; nevertheless poisoning the boy with chloroform or stunning him would have the same effect on the dog as inhibition, but in this case we have devitalized the boy: it is Lähmung not Hemmung.

Type 3. Turning now to the sphere of the exclusively physical, to the inhibition of physiological states by physiological factors, there are two types: one the inhibition of the activity or tone of some organ—heart, blood-vessel, iris, gland or sphincter muscle, as the case may be—and the other of some centre in the nervous system.

The former, inhibition at the periphery, as involving the fewer factors, may be examined first.

A typical example is the artificial stimulation of one of the nerves to the heart, the vagus, when there is produced an immediate slowing of the rate and an enfeebling of the force of the heart. Evidently this nerve is for restraining the heart's action, and it may be called its inhibitory nerve. (B in Fig. 2.)

Apparently its duty in the intact animal is to be ready to slow the heart, since this is always what happens when the nerve is stimulated or irritated under artificial conditions.

We need not at the moment detain ourselves by asking what is the object or meaning of such a nerve: so far as experiment can throw light on its function it is to be in readiness to act as an anti-motor or calming influence on the heart. In many circumstances obviously this cannot but be to the advantage of the heart. It is a very impressive sight to see a vigorously beating heart stop as though shot through when only a feeble electric discharge has been sent across the wires over which the inhibitory nerve to the heart is laid.

Many of the other bodily organs are susceptible of similar inhibition. There are certain nerves which when stimulated can, respectively, dilate the blood-vessels, increase the size of the pupil, prevent further secretion from a gland, or finally cause the firmly contracted sphincter of a hollow viscus to relax. Most of these, however, are only occasionally in action; they are potential inhibitors ready to inhibit, but not always doing so.

To witness one of these inhibitions is very striking. We can fix a pair of small needles under a nerve in a chloroformed animal, and, on passing electric shocks through them, find that certain small blood-vessels which were not previously noticeable have now become widely dilated and engorged with crimson blood. The nerve we have stimulated must be a dilator nerve, because when it was irritated certain blood-vessels had their calibre at once increased; this is what we mean by vaso-dilatation, but it is clearly the same thing as inhibition of the tone of the previously constricted vessels.

Equally striking is the similar experiment of stimulating a nerve in the neck and noticing that the pupil is at once enlarged to many times its previous diameter. Here we must have discovered the inhibitory nerve of the iris, the nerve for dilating the pupil.

There are also nerves the stimulation of which dries up glands whose secretion was previously profuse.

Although these peripheral inhibitions have been brought about artificially, yet the nerves whose stimulation has done these things must in the intact animal have been performing or ready to perform these physiological inhibitions.

Reflex Action.

Of the inhibition of a centre by a purely physiological factor there are many examples, and they are all of the nature of "reflex actions."

Reflex actions are physiological activities produced at the periphery of the body, not by the direct stimulation of the motor nerves concerned but by the centre whence these nerves issue, having been stimulated by impulses which have themselves ascended along sensory nerves from the periphery. (C in Fig. 2).

As a concrete example let us take the case of the eye watering from a piece of grit in it. In reality the eye

does not water, and it has no grit *in* it ; but the irritating particle under the eyelid is the cause of the greatly increased activity of the lachrymal gland in the orbit. Here the impulses which are causal for the weeping must have ascended sensory (afferent) nerve-fibres and stimulated to increased activity the centre for the secretion of the gland. This is a reflex action—a sensori-glandular one—of the positive order.

Now, curiously, there are also reflex inhibitions ; but the same neural scheme is utilized in these restrainings, quellings or negative reflexes. The impulses arising at the periphery ascend to a centre and then restrain its tone, so that the action over which it presides is reduced in intensity, restrained or abolished as the case may be. The vaso-motor centre gives us an example of what is meant ; the office of that centre is, as we have seen, to emit such impulses as will keep the calibre of the muscular arteries or arterioles relatively small (tonically contracted).

Now we know that round about, say, a wound of the skin, the blood-vessels are highly congested or flushed. This in physiological language means their tone has been inhibited, but it has been inhibited *reflexly* through the irritation of the sensory fibres in the neighbourhood of the wound conveying to the vaso-motor centre such impulses as have inhibited its tone, with the result that the arteries become dilated and therefore engorged with blood. Hence the congestion and swelling that for a time surrounds a healing wound is due to reflex inhibition, a negative reflex action.

Another good example is the reflex inhibition of the heart-beat which may occur during painful stimulation of some sensory nerve. This was what happened sometimes during very severe operations in the pre-chloroform days, and what may yet occur from such a painful condition as peritonitis or from a blow on the abdomen : the heart may stop and not start again ; the inhibition has gone on to death.

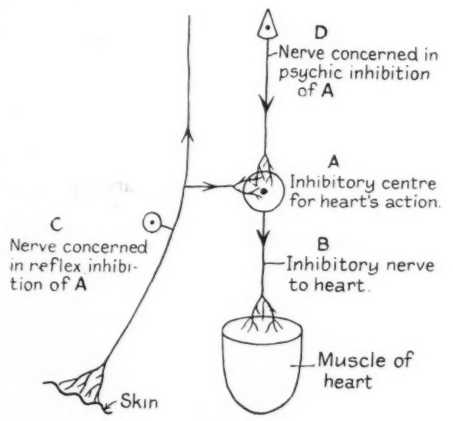


FIG. 2.
DIAGRAM TO ILLUSTRATE PSYCHIC AND REFLEX INHIBITION OF THE HEART.

The Mechanisms of the Process.

We shall in conclusion make some attempt to explain the mechanisms of inhibition.

Clearly no one explanation need necessarily be sufficient to cover all the types of inhibition ; for to begin with, it does not follow that the mechanism of peripheral inhibition need be the same as that of the central or intra-neural. The peripheral type is anatomically the simpler, but physiologically it may be the reverse.

The typical case is that of a tonically contracted sphincter which, on receiving impulses from one of its nerves, relaxes and allows the contents of the viscus to escape. The circular sphincter muscle, which is always *tending* to *relax*, is kept tightly contracted by tonic or motor impulses continually reaching it through a special augmentor nerve ; we know this, because if this nerve be cut the sphincter at once relaxes. But an equally effective relaxation can be brought about by the stimulation of the other, the inhibitory, nerve, in which case, presumably, impulses descending towards the sphincter interfere there with the tonic or motor ones. Such an inhibitory nerve is only occasionally in action.

These inhibitory impulses perhaps interpolate resistance between the motor nerve-endings and the muscle of the sphincter. It may be a case of anti-motor or negative impulses (−) cancelling the motor or positive impulses (+) ; or it may be that the inhibitory (negative) impulses act functionally by inserting a resistance to the passage of the motor impulses from the special augmentor nerve to the sphincter muscle.

When we come to explain the inhibition of a centre we seem to be on surer ground.

One of the most probable theories is that of the removal of innervation from a centre by drainage.

A concrete example will make this clear :—" The man at the wheel " is giving all his attention to the business of steering the ship ; in physiological language his brain and cord centres are co-ordinating the continual neuro-muscular movements of his eyes and hands. If now someone speaks to him, or his attention becomes in any way engaged, the innervation to the muscles of the eyes and hands becomes feebler, and the result may be such a disturbance of the co-ordinations that the consequences to the ship are serious.

Nerve-energy has been drained off from the motor centres into the hearing centre, and therefore less is available for the governing of the muscular movements.

Drainage of Nerve Energy.

These centres may be said to be inhibited—the intensity of their action has been reduced by the draining of nerve-energy from them.

This is what underlies our being unable to do two things well at the same time.

This theory of inhibition by drainage is associated with the name of Professor MacDougall of Harvard University.

The drainage theory also accounts for the inhibition or paralysis of a brain-centre in the hypnotic trance. When the attention of the person is firmly fixed upon something—the "passes," etc., of the hypnotist—that is, when the centre for vision is actively engaged, then the "centre" for pain, for instance, may be inhibited by the drainage of nerve-energy away from it into the centre for vision. The pain-perceiving centre may thus be so profoundly depressed that the hypnotised person is able to endure degrees of surgical injury which in the waking state would be distinctly painful.

The view that certain hypnotic phenomena are inhibitory in nature is associated with the name of the German physiologist Rudolf Heidenhain.

The theory of inhibition by interference of nerve impulses may apply to centres quite as well as to peripheral organs. Once more, a concrete case had better be considered: a person is about to sneeze, say, from a tickling in the nose; this is a reflex expiration; but strong pressure on the upper lip will prevent the sneeze "coming off." It is useful to know this if the sneeze should happen to be imminent at some inconvenient moment.

On the theory of interference it is assumed that the motor impulses to the muscles of inspiration (whose violent contraction constitutes the sneeze) are effectually interfered with by sensory impulses coming up by a nerve from the skin of the lip. These two sets of impulses, the motor and the anti-motor, meeting over the respiratory centre, interfere with each other and leave the centre unstimulated. This type of inhibition is that of the mutual antagonism between two sets of different impulses impinging simultaneously on the same centre.

Most neurologists would agree that something of this sort does actually take place in the centres of the nervous system.

Physiologically it is quite clear that inhibition by active restraint (Fig. 1) or by the interpolation of resistance is something quite different from inhibition by drainage.

In the former type a centre, say, is *actively restrained* by what we may call anti-motor impulses either of cerebral or lower (reflex) origin; while in the second type the centre is receiving less innervation than before, and therefore emitting the impulses proper to it less intensely than before.

Professor MacDougall, who introduced the theory of inhibition by drainage, would not assert that all inhibitions are of this nature; and it is perfectly possible that since Nature is so fertile she is able to employ more than one type or method.

There must be a fundamental difference between the active quelling of the excitability of a centre and merely withdrawing from that centre some of the nerve-energy it was previously receiving.

The Several Theories.

To sum up: our study of intra-neural inhibitions has led us to the conclusion that in all probability there are several types or modes of inhibition in the living body as regards peripheral tissues; one type is that in which resistance is interposed by the impulses in an anti-motor nerve at the particular place where the motor or augmentor nerve is distributed to such a tissue as a sphincter muscle. The normal, "tonic," motor (+) impulses are either blocked out by the anti-motor (—), the inhibitory impulses, or are "cancelled" by the latter, as a plus cancels a minus. Exactly the same mechanism may be functional in a nerve-centre, for instance, in the spinal cord where, again, the inhibitory impulses may be of the nature of resistance to the passage of the motor ones (+) or there may be mutual cancelling of tendencies, leaving the centre in the *status quo ante*. Or, lastly, some of the nerve-energy normally reaching a centre may be drained off, leaving it in a state of depressed tone.

But outside the nervous system inhibitions of an order still more subtle are now freely recognized as among the postulates of biology. These are related in some mysterious fashion to the activity of the internal secretions. The mechanism of the production of secondary sex-characters is becoming better known as experimental biology progresses. The part of this process that interests us just now is more especially the inhibitory as alluded to in the following sentence from "Internal Secretions" by Professor Weil, of Halle:

"Inasmuch as a cock-like growth of feathers occurs in old hens, we may assume that in this species the ovary *inhibits* the growth of feathers."

Later this author speaks of "the *inhibitory* influence of the female germ gland upon the growth of the skeleton."

We wish at present merely to point out one more kind of use in biology of the concept inhibition, in this case one related to the hormones produced by the sex-glands.

There are other examples of hormones with inhibitory power, so that it would seem as though inhibition in the realm of the bio-chemistry of the tissues was just as fundamental as that exhibited within the realm of the nervous system.

Some people seem to think that all stimulation is in the direction of stirring up activity. This is a great mistake; Nature is constantly employing stimuli with an exactly opposite tendency, the reduction or quelling of activity.

Breeding Pearls.

By Sir Arthur E. Shipley, G.B.E., F.R.S.

THERE is a widespread belief throughout Burma, Singapore, the Straits Settlements, and the Islands of the Malay Archipelago, that certain pearls in certain conditions can reproduce themselves. These breeding pearls vary in size, but are not very big; they are alleged to be laminated. According to Dr. W. B. Dennys,* Professor Huxley examined some of these and states that he subjected one of them to various tests and declares that it was indistinguishable from the ordinary pearl used for jewellery.

To persuade these pearls to reproduce you must place four or five of them in a box with fifteen to thirty grains of uncooked white rice. They must not be shaken or disturbed in any way, though some observers say this precaution is unnecessary. Re-examined after a period of a year it is alleged that small seed pearls will be found at the bottom of the box, whilst the original pearls have themselves increased in size. Further examination a year later is said to show that more seed pearls are found, and that the older pearls are still growing. It is said that the grains of rice have a bite taken from each end. Dr. Dennys examined a collection of pearls, and he confirms the above statement. The Medical Officer of Health for Singapore some fifty years ago confirmed his statement and quoted a letter from an unknown lady in which she states:—"I had three 'Breeding Pearls' given me in June or July 1874. On the 17th July I shut these three up with a layer of cotton wool above and below them and some few grains of a very fine rice (called here 'Pulot' rice). On the 14th of July, 1875, we opened the box in the company of two or three friends and we discovered *twelve* of sizes—the three original ones standing out distinctly by their greater size; though some of the newly-bred ones were by no means insignificant to look at. One or two were about the size of a pin's head and perfectly round. The rice looked crumbly and worm-eaten." These breeding pearls are stated to have come from various species of oyster and clam, some of them from the huge Tridacna. Dr. Dennys also recalls other observations made by various experts who treated the pearls in the ordinary way with absolutely no result. In *Land and Water* for 25th December, 1878, Mr. Hugh Owen states that Her Highness the Ranee of Sarawak sent him a test-tube containing a few genuine seed pearls and five small cowries, the ends of which had been filed off so that they came to resemble rice. In his opinion the whole thing was a fraud.

A few weeks ago I received specimens of these pearls from my friend Mr. J. H. N. Evans, of the Federated Malay States Museum at Kuala Lumpur. They were very small and accompanied by four grains of rice which, as far as I could observe, are untouched. The man who gave the specimens to Mr. Evans was a lawyer married to a Burmese, and he was quite convinced that his wife's pearls do breed. The so-called pearls did not look to me much like pearls, though they had a rather cloudy appearance. Mr. A. Hutchinson, of the Mineralogical Department at Cambridge, kindly examined these objects and found that they were insoluble in acid, easily melted, and were glass—probably a lead glass. They were unusually heavy, having a specific gravity of 3.2. The only indication of breeding was that one or two of the specimens were dumb-bell shaped, looking as if they were going to divide. Of course, it may be that Professor Huxley received real pearls, otherwise it is difficult to account for his reputed statement, as there is no doubt at all that those which reached me as breeding pearls were glass.

**Journal of the Straits Branch of the Royal Asiatic Society*; July 1878, No. 1.

Three-coloured Signals.

Two colours have hitherto been used in railway signal lamps, but a third is now being introduced on certain British lines. Under the old system a red light was a warning on a distant signal and a stop on a home signal, and this entailed both a risk of unnecessary delay and even a danger of over-running a "home" from failure to observe its corresponding distant signal. After some years of research a distinguishable glass of a moderately deep orange colour has been discovered, which in foggy weather tends to approach the appearance of a red signal, and so cannot be mistaken for the green.

The Aims and Practice of Factory Ventilation.

By T. C. Angus.

Generally-accepted ideas about ventilation have undergone remarkable changes during recent years, as a result of research undertaken by Professor Leonard Hill, F.R.S., to whom the author is engineering assistant, at the National Institute for Medical Research. The discovery of the basis of proper ventilation and its application to factory practice are of the utmost importance to industrial efficiency.

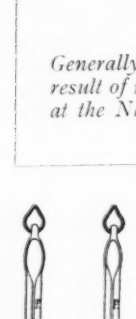


FIG. 1.
THE TWO TYPES OF KATA-THERMOMETER.

WHEN we think of ventilation, or of a place being "ventilated," we usually think of the supply of fresh air and the removal of used-up or foul air, coupled with the idea that ventilation is one of the great necessities of health because to breathe once-used air is bad for us.

It is now known that this is at once an overstatement and an understatement of facts, because in comparatively few places is the air so much used-up or fouled by the persons breathing it that any special means are called for for renewing it on this account, but also that, in a great many instances, other powerful and unsuspected agencies are present that require our attention if healthy and comfortable conditions are to be obtained.

To take an everyday example: consider a factory room where people work seated at tables on the ground floor with southward looking windows and one or two ordinary doors. In winter time it is warmed to about 60° F. by the usual hot-water arrangements and on typical winter days with westerly winds, perhaps rain, and an outside temperature of 42°-50°, you will find one or two windows open at the top and the room generally comfortable. Suppose the weather changes in the night and the hot water supply is, for some reason, rather deficient next morning; the wind has dropped and the sky has cleared and there has been a morning frost: the room will be unpleasantly chilly all the morning and *you will not find any windows opened until after the dinner hour.*

Now consider the same room on a hot summer day. There is just the same number of people working there and the same work being done, but now the room is unbearably "stuffy" and "airless" unless the windows can be opened wide: dust or other causes may prevent this, in which case the room will become steadily more unpleasant until well on in the afternoon. It is apparent that although this discomfort in hot weather is due to bad ventilation, it cannot be due to impure air, because on the cold day every possible entrance for fresh air was closed, and although the room felt chilly nobody felt it stuffy or "airless"; on the hot day all possible doors and windows were opened and still the room needed more ventilation.

Oxygen Shortage.

If we examine the "foul air" theory of ventilation we see that in no instance does the oxygen content of an industrial room become diminished to a harmful extent by the breathing of its occupants. Many analyses have shown that in the worst ventilated rooms, theatres, or public meeting-places the oxygen content of the air is never lessened by more than 1 per cent, and very rarely by as much, from the 21 per cent found out of doors. "Natural ventilation is kept up by the increase of temperature and moisture within, which lightens the air, and by the wind outside. This taking place through every chink and cranny, chimney opening, porous brick wall and plaster ceiling . . . " (Leonard Hill).

Similarly it has been found that carbon dioxide never in any circumstances increases to a harmful extent in ordinary buildings. Three parts in 10,000 is the normal proportion in country air, and four parts in 10,000 in London air. Men in breweries work for years in air containing 100 to 200 parts of carbon dioxide per 10,000, and retain excellent health, while men in submarines are willing to remain submerged until the content rises to 300 parts. In the worst ventilated rooms, theatres, courts of law, schools, etc., the carbon dioxide seldom rises to above 50 parts in 10,000, and never above 100 parts.

The Poisons in Breathed Air.

Apart from carbon dioxide there has long been an idea that air once breathed by man or by animal contained some subtle organic poison which could damage the man or animal that breathed it again. This idea was first put into scientific form in 1881 by two writers in a French publication, and Dr. Leonard Hill says that their "statements have done very great mischief to the cause of hygiene." Their

experiments, upon animals, have been many times repeated with the greatest precautions, and it has been definitely proved that no such poisons exist. The same has been found true for man.

But although once-breathed air has been definitely shown to be non-poisonous of itself, it can be very harmful in other ways. Respiratory diseases, coughs and colds, are carried by microbes which float in the air suspended in minute droplets of moisture sneezed or blown out by the sufferer, and in a crowded and badly ventilated room, in an overheated train, or dance hall, massive infection by these microbes takes place, and Dr. Hill has proved that the fact of these places being, as they always are, warm and moist, renders our noses and breathing passages less able to repel the attacks of these microbes.

Odours.

The odours of trades or of hot and crowded people have a very disturbing effect on many persons, though even this is an entirely nervous and not a physical effect and one to which many people are quite oblivious. Dr. Hill writes: "The sight of slaughter and the smell of dead meat and offal may be loathsome to the sensitive lady, but butchering is a healthy trade. The stench of glue-works, fried-fish shops, soap and bone works, middens, sewers, becomes as nothing to those engaged in or on such, and the lives of the workers are in no way shortened by the stench they inhale . . . sewer men are as healthy as other town labourers."

All this shows that while efficient air-changing is of great importance in really crowded buildings such as schools and theatres, it is usually of very little importance indeed in most industrial buildings where there seldom is any real crowding of people. Of course, where much steam, deleterious fumes or dusts are produced, special means are called for; but here it is much better to trap and remove the fumes at their source than to try to condition the air after it has been polluted by them.

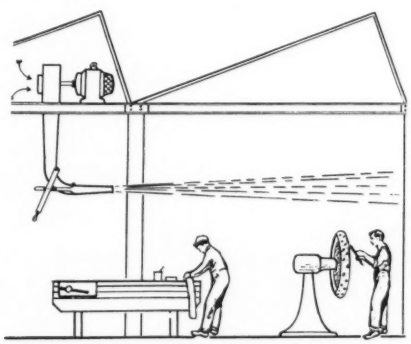


FIG. 2.
JET TUBE ARRANGEMENT FOR WORKSHOP VENTILATION.

Cooling Power of Air.

It has now been definitely established that in nearly all the ordinary cases of bad ventilation and stuffiness it is the *physical* and not the *chemical* properties of the air which are at fault. Those desiring proofs of this statement are referred to the list of books and publications at the end of this article for accounts of the experimental evidence.

To Dr. Leonard Hill we are indebted for the first practical and readily accessible means of measuring these physical properties of the air in buildings, and for establishing scales of comfort which are independent of the feelings and sensations of any individual.

It is generally recognized that the human body is warmer than its surroundings, but not always recognized that it is always losing heat to its surroundings, and that to work efficiently it is as important for it to lose heat at the correct rate as it is important for a motor-car to have a properly filled radiator, or a steam-engine a properly-designed condenser. Probably this is less readily recognized because the body is such a wonderfully adaptable machine that it can put up with misuse for much longer periods than man-made machinery; though in the end the effects must appear in an untimely breakdown. The human engine is always working whilst life lasts. Even in sleep mechanical work is being done in circulating the blood and breathing, and food is being oxydized, with liberation of heat, for this purpose. When a man moves he uses more food and he generates more heat; when he works hard or runs he generates still more, and has to evaporate sweat before he can keep his body temperature down to normal; he wants to work in an atmosphere of greater *cooling power*.

Dr. Leonard Hill measures the cooling power of the air by his "Kata-thermometer"—an instrument with a large bulb that is warmed to about the temperature of the human skin and whose rate of cooling thus gives an indication and measurement of the power of the air to cool the human body. Figure 1 shows the "Dry Kata" and the "Wet Kata"; the former is used in cool atmospheres where the skin is hard and dry, the wet model for hot atmospheres where the body is always moist. Readings with the "Dry Kata" alone give all the information necessary in most cases where the temperatures are moderate; readings with both wet and dry instruments give a fuller indication, the "Wet Kata" being of the greater value in very hot atmospheres. The instruments are used by heating the bulb in hot water, holding at arm's length in the air to be investigated, and measuring

the time in seconds taken for the liquid to fall from 100° F. to 95° F. This time in seconds is divided into the "factor," a figure marked on the stem of each instrument, giving the value of the cooling-power of the air as quotient.

Thus if Time of Cooling=63 seconds; Factor=410; then Cooling Power=$\frac{\text{Factor}}{\text{Time}}$=6.5 millicalories per square centimetre per second—that is, the rate at which heat is passing through every square centimetre on the bulb. A number of cooling-power values taken from hundreds of readings in factories and schools are set out below, and these show how great a difference in sensation accompanies changes of cooling power (amply verified in practice).

COOLING POWER VALUES.

Dry Kata	Wet Kata	Dry Bulb		
8.5	26	54.5° F.	Winter day, sedentary workers, too cold for comfort.	
6	18-20	63.0	Sedentary workers, comfortable condition.	
8-12	22-26	65.0	Cross-circulation with hopper windows on cool summer day, excellent conditions for fairly hard work done in factory.	
3.0	13.0	82.5	Warm summer day, serrated roofed one-story factory, enervating conditions, fans required to blow air in on workers.	
10-6	24-13	63-57	Ordinary Room	Maxima and minima on June days, 1916.
6-5	15-13	—	Art School	
24-12	49-33	60-55	Road	
12-7	24-16	64-48	Ordinary Room	Maxima and minima on March days, 1916.
8-5½	17-13	—	Art School	
39-18	65-36	56-37	Road	

The last six lines show the contrasts between an ordinary room, an art school, and out-of-doors, exposed to the wind, in Sunderland. Note "the monotony of the cooling powers in the art school, and the great difference between occupation in this and in the open air, the artist's and the road worker's conditions; contrast the neurotic temperament common to the one and the rude health of the other."—(Leonard Hill).

Now the vital difference between the readings of the "Kata-thermometer" and the ordinary thermometer, is that the "Kata" is affected by air movement whilst the ordinary thermometer is not; the "Kata" cools more quickly in a draught, unless the temperature of the air is above 100° F., when the dry "Kata" *heats* more rapidly the greater the air velocity. Thus the cooling power of the air depends upon (1) its temperature; (2) its rate of movement past the object to be cooled; (3) its dryness.

Figure 3 shows a plan of an experimental wind-tunnel built at the National Institute for Medical Research for testing the "Kata-thermometer" and other instruments against human sensations and efficiency. The central passage is open at both ends and air is drawn through it at any desired speed by a large fan, shown at the top. The air passes over hot pipes where it can be heated as desired, with or without the addition of steam to control its humidity, and it then re-enters the central passage through the "honeycomb" box arrangement at the near end, designed to eliminate eddies and whirls. A conveyor or moving platform is shown on which a subject can be made to walk or run so as to do mechanical work under varying atmospheric conditions. The air speed can be measured very accurately by a Pitot tube and Chattock gauge.

We find that by the use of the "Kata" we can say how suitable or unsuitable any conditions are for different kinds of work, moreover, we can say what has to be done to improve bad conditions. The formula of the "Kata" tells us that to gain a sufficiently low cooling power in a hot room, either the room must be made cooler or the air must be given a definite movement, and *within small limits it does not matter which is done.* Of course, no amount of air movement will relieve very intense heat, especially if the air is nearly saturated, but under ordinary conditions of industrial discomfort a very great deal can be done by moving the air, even the hot air.

By means of a special chart* (Figure 4) the relation between temperature, air movement, and velocity for the dry "Kata" can easily be determined. For example, with a temperature of 80° F. and an air movement of ten feet per minute we have have a cooling power of 3—a condition often found in factories and laundries in hot weather, and very unsatisfactory; but by increasing the velocity to 200 feet per minute the cooling power rises to 6, to the great relief of all.

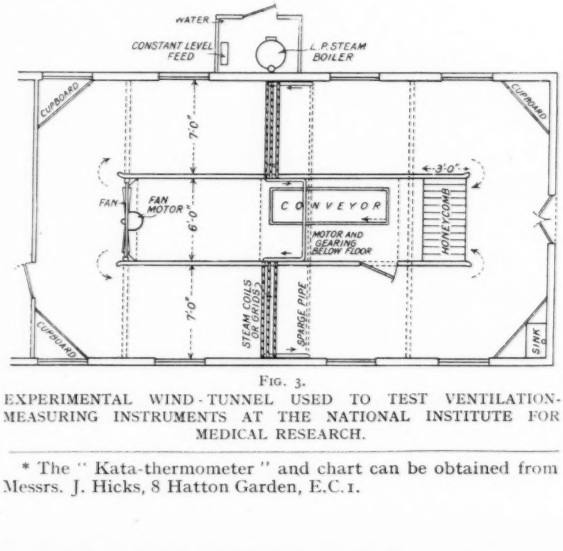


FIG. 3.
EXPERIMENTAL WIND-TUNNEL USED TO TEST VENTILATION-MEASURING INSTRUMENTS AT THE NATIONAL INSTITUTE FOR MEDICAL RESEARCH.

* The "Kata-thermometer" and chart can be obtained from Messrs. J. Hicks, 8 Hatton Garden, E.C.1.

But if an air velocity of 200 at a temperature of 58° F. be arranged, a cooling power of 13½ results, with an unbearable draught which no one will put up with at any ordinary work done indoors.

The chart is used by placing a straight-edge or a thread so as to cut the three scales, when the relation between temperature, cooling power, and air velocity is at once established. In this way the air velocity necessary to produce a desired cooling power at any temperature can be determined, or the cooling power resulting from any temperature and known velocity. The accuracy of this chart is not great at very high temperatures, but it may be considered to be quite good enough for workshop use. Only a part of the chart is reproduced here.

To Obtain Desirable Cooling Power.

Natural ventilation through windows, doors and skylights is the simplest and least expensive method of dealing with hot atmospheres in hot weather. It can prevent a large excess of inside temperature

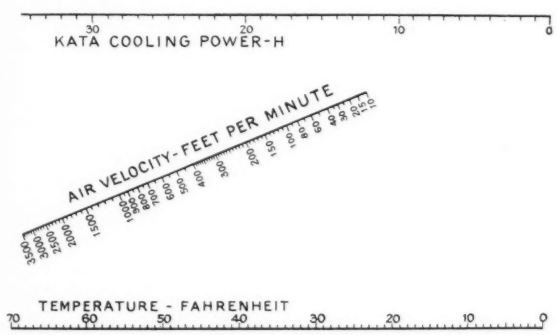


FIG. 4.
CHART FOR DETERMINING COOLING POWER FROM OTHER FACTORS.

above that found out of doors, and can be made sufficient to allow enough air movement to prevent very low cooling powers.

Natural ventilation has been applied in rather a haphazard way as a rule, and an attempt was made to express the natural ventilation of a building by a figure, "O," the "opening figure," equal to the number of square feet free area of open doors and windows × 1,000, ÷ cubic feet content of building.

"Kata" readings, taken on the same days in summertime in buildings with different "opening figures" showed that buildings with small figures invariably had low cooling powers, and vice versa. A very striking instance of this is shown in Figure 5—an old and a new rubber moulding shop, where precisely similar work was being done and where the opening

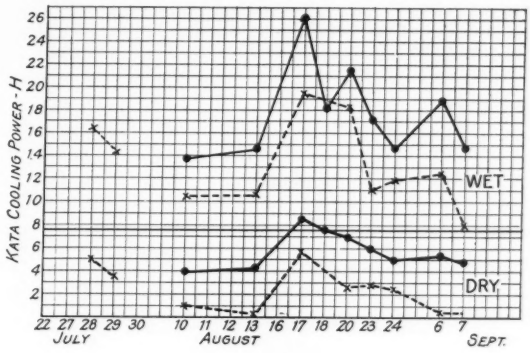


FIG. 5.
KATA-THERMOMETER READINGS TAKEN IN NEW AND OLD MOULDING SHOPS, SHOWING ADVANTAGES OF IMPROVED VENTILATION.
(Solid line = new shop; broken line = old shop.)
In new shop doors = 7.3; roof openings = 1.36; making opening figure 8.66.
In old shop doors = 1.62; roof openings = 0.70; making opening figure 2.32.

figures were 2.32 and 8.66 square feet per thousand cubic feet, respectively. The curves show a consistent difference between the two places, which the feelings and appearances of the workmen fully bore out. The new moulding shop had ten feet by two feet door-windows and large skylights; the old one much smaller skylights and no windows.*

Mechanical Ventilation.

In many places sufficient natural ventilation is impossible, for various reasons, and mechanical means have to be adopted. To change the air in a large industrial building sufficiently quickly to keep temperature down and movement sufficient in hot weather requires a plenum system so big and costly that in practice such systems are never found, unless they are necessitated by the needs of the process; the human desirability alone is not sufficiently strong to warrant the expenditure necessary for putting in a really large plenum system. Small plenum systems in such connections are invariably unsatisfactory and disappointing.

To meet conditions where high but not prohibitive temperatures occur, and where good natural ventilation is made impossible for any reason, the writer has introduced the jet tube system of ventilation by air stirring, or air circulating. The object is to impart movements of a desirable kind to the greatest possible volume of air at a four to seven feet level in a building, that is, over a region round the upper parts of the occupants, and the method used is to drive a powerful, flat, wide stream of air above their heads, so that they do not come into contact with the stream but are

* For full report of this research see reference at end: T. Angus, *American Journal of Industrial Hygiene.*

cooled by the gusts, eddies and whirls of air which take place below and around it and by the general drift which all the air in the neighbourhood obtains from the jet's force.

In this way cooling powers can be raised and air stagnation relieved over more than 1,300 square feet of floor space by one jet tube operated by a one-horse-power motor without introducing any fresh air at all. It is sometimes useful to bring in fresh air through jet tubes, but it is generally found better not to do so. Jet tubes may be fitted to plenum systems instead of the usual outlets, thereby gaining a better distribution of air and improved cooling powers. Figure 2 shows the usual arrangement of jet tube, as fitted up to operate over a distance of 100 feet of workshop length.

Of course there are other means of obtaining the same ends: moving belts and machinery do a lot of air stirring; paddles are often fixed to shafting and oscillating flaps have been fitted to looms with good effect. Small electric fans give excellent results in offices, as is well known, and are sometimes used effectively in factories when distance is not too great.

Air Cooling.

This can be done effectively when there is a cold-water supply, by air washing,* but so far is only justifiable on the ground of expense when the process demands it. It is often used in the manufacture and preserving of food.

It is well to bear in mind the mechanical characteristics of fans, for often a fan is bought and blamed for refusing duty when it is put to do work for which it is entirely unsuited. In centrifugal cased-type fans air is drawn in axially and delivered tangentially through the rectangular opening at a high velocity; and these fans can be designed to deliver air at almost any desired speed or pressure. The cheaper ring or propeller-type fans can move a large volume of air, but only at a low velocity and against very small resistance—less than $\frac{1}{8}$ in. water gauge. They must never be used for driving air through long ducts, small holes or even against a strong wind; this stops the delivery and at the same time increases the load on the motor and may even burn it out.

BIBLIOGRAPHY.

Medical Research Council Special Reports: "Science of Ventilation and Open Air Treatment." Parts 1 and 2. Nos. 32 and 52; "The Kata-thermometer in Studies of Body Heat and Efficiency." No. 73; "Methods of Investigating Ventilation and its Effects." No. 100. (H.M. Stationery Office.)

"Health and Environment." Leonard Hill and Argyll Campbell. (Arnold.) (Sums up the findings of the first three M.R.C. reports.)

"Report of New York State Commission on Ventilation."

"Some Modern Methods of Ventilation." Grierson. (Constable.)

"The Ventilation of English Factories and Workshops in Hot Weather." T. Angus. (*American Journal of Industrial Hygiene*. March, 1923.)

"Air Washers and Air Filters." H. W. S. Martin, A.M.I.H.V.E. (*Institution of Heating and Ventilating Engineers' Report*, 1924-1925.) (With reference to cooling air).

* See Bibliography—H. W. S. Martin.

Synthetic Rubber.

It has been stated that a firm in Hanover is successfully manufacturing synthetic rubber from potatoes. It has been suggested that this probably refers to the isolation of isoprene from potatoes and their by-products and its conversion into a mass similar to crude rubber. This, however, can hardly be the case, according to *The Chemical Age*, which states that isoprene has been produced from two by-products of starch, namely, fusel oil and lactic acid, but these processes are at present uneconomical. The German firm are probably engaged in the preparation of dimethylbutadiene-rubber (the so-called methyl-rubber) which was commercially the most successful material prepared in Germany during the war. Dimethylbutadiene is readily obtained from pinacone and the latter from acetone.

The first process for the preparation of acetone by fermentation was due to Dr. Fernbach and was originally carried out on an industrial scale in England. During the war a modification of this process by Boettinger was successfully worked in Germany. Essentially, it consists in fermenting a suitably prepared potato mash with the aid of Bacillus Macerans, an organism found in rotting potatoes. Dimethyl-butadiene is very readily polymerized to synthetic rubber. During the war the Germans achieved this by enclosing dimethylbutadiene in iron drums which were kept at 60°C. for from four to six months. The production of synthetic rubber both in the laboratory and on an industrial scale was first carried out in England, and the activity of continental firms should stimulate our manufacturers to fresh efforts to maintain their lead in this promising and highly important field.

Correction.

In the review of the book "Musical Taste and how to form it," which appeared in our March issue, the author's name was unfortunately misspelt. It should have read M. D. Calvocoressi.

The Cape Malays: A Moslem Survival.

By Lt.-Comm. C. F. Jepson, R.N.

Interesting evidence of the survival of a religion among a people cut off from its native land is afforded by the little-known history of the Cape Malays. Transported from Java as slaves in the seventeenth century, the Malays have continued to practise the Mohammedan faith, as the following account of their customs shows.

AMONG its million of subjects the British Empire counts more Mohammedans than any other Power, and although it does not always pay close attention to their aspirations—legitimate or the reverse—the religion of the Prophet is slowly but surely spreading. In Africa it has had as its age-old base-line the country that lies between Cairo and Zanzibar; thence it has spread westward through the two Sudans, displacing the ingrained fetishism of the negro and, should it ever penetrate fairly into the Union of South Africa, it will find joyfully awaiting it two groups of the true believers—the Moslem Indians of the Transvaal and Natal, and the remarkable people of mixed race known as the Cape Malays.

A CAPE MALAY BRIDE, IN HEAD-DRESS DECORATED WITH ORANGE-BLOSSOMS.

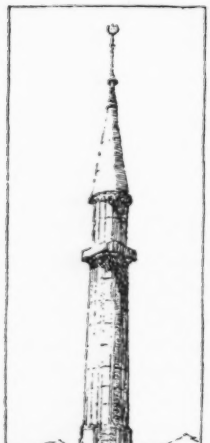
Since the seventeenth century the Cape Malays have formed small particles in that jumbled patchwork—the ethnographic map of South Africa. In 1652, or soon after, the Dutch conquerors of Java began to transport troublesome Malays to the Cape of Good Hope, there to end their days as slaves of the East India Company or of burghers. Little can be told of their existence in those days, or of their gradual growth as a slave community. The exercise of their religion was denied them, the building of mosques was forbidden, their native tongue discouraged; yet, in some way mysterious to those who do not know the East, they clung to their faith, which survives and flourishes to-day, while their language has almost vanished.

In the course of time it became permissible for a slave to purchase his freedom; the freed Malays soon became rich by dint of thrift and a standard of living only endurable for an Asiatic. Given wealth, religious fervour could find some outlet, in however covert a manner. It became the hope of every freed Malay to be able to send one of his sons on the costly and hazardous journey to the ancient Ahzar University at Cairo, or to holy Mecca. To do so meant surrendering him to exile for five years at least, with the risk of death or slavery at the hands of Arab marauders. But the sacrifice was cheerfully offered; it renewed the connection between the hub of Islam and the faithful whom fate had transformed into an isolated slave-community at the Cape. Religious toleration appears to have gained a foothold in Cape Town in 1800, when the first mosque was openly used.

Towards the close of Dutch rule partial freedom could be obtained by joining the forces of the colony. The energetic Governor, General Jansens, resolute in resisting by every means the anticipated British invasion, raised a Malay regiment—the Javanese Artillery—of whom he speaks well. In 1806 they fought in the battle of Blaauberg, when General Sir David Baird defeated Jansens.

To-day the Cape Malays are a thriving, virile, yet inoffensive race. In the language of the report on the 1921 census, they have "to a large extent lost the distinctive Asiatic characteristics (apart from their religion) and have, to a certain degree, become associated with the indigenous population of their districts." They are "with few exceptions located in the urban areas of the Cape Province." They have "intermarried freely with the aboriginal and coloured (*i.e.*, half-breed) races, and with Europeans." They have generally the brown eyes of the Asiatic, never greatly tending towards the "almond" shape, and often of great beauty. Their hair is usually jet black and straight, the women waving so much of it as appears from beneath their bright scarves. The men wear the red or black fez from infancy; it has entirely displaced the ancient hat of Malaya. In all respects other than the use of plain wooden sandals by the older and poorer folk, the dress of both sexes is European except on ceremonial occasions.

Probably the Malay differs most widely from other Moslems in the freedom he allows his women. Poly-



MINARET AT THE TOMB OF SHEIKH YUSUF, CAPE TOWN.

gamy is rare in the Cape Province; in the 1921 census only twenty-seven men, all of them Malays, are noticed as having more than one wife. Among the wealthy and orthodox the women never appear out of doors unless closely veiled; but the great majority of women enjoy a measure of freedom that is incompatible with the spiritual ignominy to which Islam condemns them. They take an equal part with the men in business and pleasure, and though excluded from most religious exercises they may be seen praying at the graves of saints, or even reciting prayers at meetings of Malay women's benevolent societies—of which one, at least, is in a flourishing condition. While the men pursue the outdoor side of their fishmonger, laundry, butcher, and fruiterer businesses, the women conduct the indoor side; but, judged by their standard of cleanliness, Malays are rarely fit persons to carry on the laundry work that is theirs by tradition. In the narrow lanes that ramble amongst whitewashed cottages of the Malay quarter children, dogs, goats, and poultry share the sunlight with men, women, and washing.

A Malay Wedding.

A Malay wedding, if the parties enjoy anything like comfortable means, is an event that concerns the entire quarter and involves a whole holiday, usually taking place on Sunday which—since Friday is the Mohammedan day of prayer—is to the Malay no more than a civil holiday. The business of getting married begins early in the day. At about 8 a.m. the bridegroom, unaccompanied by his spiritually negligible bride, proceeds to the mosque with his friends to hear the injunctions of the Prophet read by the *imam*, and while the marriage receives religious sanction at the mosque the bride, at a relative's house, is adorned in her first dress by a dozen busy hands. Her husband, coming from the mosque, leads her through the streets accompanied by one or two bridesmaids and groomsmen, the *imam* and the parents, to the scene of the banquet, already proceeding. Within the banqueting room every member of the community is crowded. A large cake of European style, gaudy of appearance and doubtful of taste, the handiwork of a Malay baker, is the centre of attraction, and the banqueting room will be filled by a floating population until sundown.

The entrance of the bridal party causes little interruption of the festivities, and but for observing her in the seat of honour one would with difficulty distinguish the bride. Orange-blossoms, an Eastern as well as a European mode, form part of her headdress. Having drunk sweet tea from little cups, the pair depart to another friend's house where a long interval is spent in dressing the bride in her second costume. The second visit is paid to the banquet, more tea is drunk, and so on until, the bride having exhausted her changes of raiment, the couple are escorted to the bridal chamber.

Moslem Burial Rites.

Apart from religious rites the Malays have few customs that are picturesque. Men alone attend funerals; the corpse is carried through the streets on a bier or, if a child, in the arms of its father. Like all the faithful, Malays are buried lying on one side, with a hand beneath the cheek, the head towards Mecca, robed, and with food at hand. A simple headstone of slate records identity and faith in Arabic.

The grave of a holy man, surrounded by a whitewashed wall, becomes a *karamat*, or shrine. The chief and most ancient is that of Sheikh Yusuf, near the mouth of the Eerste River. Sheikh Yusuf was a Macassar prince of influence throughout the Malay Peninsula towards the close of the seventeenth century. Of royal birth, warrior, patriot, and priest, he resisted the Dutch invader for a year, but was eventually lured into surrender. After ten years of exile in Ceylon he was removed with his family and retinue to the Cape, where death terminated his last five years of exile in 1699. He was credited with the performance of miracles. For instance, tradition asserts that during his voyage to the Cape in the "Voetboeg," when the vessel ran short of drinking-water he provided fresh water by dipping his foot into tubs filled from the sea. Knowing the reverence felt for him, the Dutch Council of India refused petitions that his remains might be returned to Java, and his tomb, surrounded by the graves of his family and followers, has been visited by thousands of his faith.

Moslem piety has enriched the entrance to the karamat with a granite tablet briefly telling his history, but a graceful minaret is being erected as a fitting remembrance of him who was the first to read the Holy Qur-an in South Africa.

Possibly Sheikh Yusuf's healing powers are commemorated in the strange performance known in the Cape Province as the *khalifat* or *khalifa*. In 1856

controversy raged in Cape Town as to the true origin of the khalifa, and the subject is dealt with in "The Califa Question" by J. Suasso de Lima, published in Cape Town in 1857. The Malays themselves are vague as to the origin of the rite, but the Arabic word khalifa means "representative of God." Demonstrations similar to it also occur in Constantinople. Partly composed of acts of faith and devoteeism, partly of tests of skill, the khalifa is too barbaric to survive much longer. To-day a community will give a performance once only in a year or so, and invariably in order to raise funds for benevolent purposes. During the Great War khalifas were held to raise patriotic subscriptions.

The whole community assembles in a convenient hall, on the platform of which several *imams* and the performers squat before a *k'aba*, a model of the holy edifice at Mecca, borrowed from the mosque. It is a shrine-like erection of wood, resembling the outline of a kiosk, and decorated with lamps, flags, and glittering crescents. It also serves as a sword rack.

Amid the excited chatter—inseparable from a Malay gathering—the swaying performers chant sacred refrains, punctuated by the throbbing of large tambourines. Incense fills the room. When the droning chorus swells to an almost unbearable intensity the chief performer leads the first devotee to the centre of the stage. Slowly and deliberately he thrusts a steel skewer into his mouth and out through the right cheek; another follows through the left cheek, two through the lobes of the ears, and two more through the flesh of the ribs. The devotee is then

[*South African Railways.*

THE OLD MALAY BURIAL GROUND ON THE LION HILL AT CAPE TOWN, OVERLOOKING THE CITY.

The whitewashed tomb seen in the foreground is a *karamat* or holy man's shrine.

[*South African Railways.*

THE MALAY QUARTER AT CAPE TOWN.

led through the audience, tambourine in hand, protected by friends from the press of people, to collect alms. A display of swordsmanship follows, and men stripped to the waist are struck with apparent force across the abdomen and loins. Hardly a trace of blood appears; this is attributed to the virtue of holiness, but it may be safely ascribed to the fact that the holes have been previously pierced. More barbarous is the nailing of a man by his cheek to the platform by means of a thick spike driven in through the mouth. Blood can be seen, and the devotee's sufferings imagined as he lies for some minutes motionless on the boards. Similar spikes are plunged into their breasts by dancers, but probably are enveloped in folds of flesh before even the skin is pierced. Swords pressed into the crease of flesh on a relaxed limb are hammered with mallets.

Religious Fervour.

As the hour grows late the *imam* suddenly casts off his sandals and, raising his voice an octave, leads a new, perfervid chorus. The tambourine-players redouble their efforts; the women and children shout anew; the *pièce de résistance* is to be presented. Two men hold a sabre edge upwards on the boards, one at the hilt and the other at the tip. Slowly the *imam* treads on the edge with naked soles; his finger-tips placed on the supporters' shoulders preserve his balance. Then, amid shouts and a frenzied mingling of chorus and drum-beat, the blade with its poised burden is raised waist-high, held awhile, and gently lowered. Thus ends a display that illustrates the remarkable state of excitement to which the Cape Malays, perhaps the meekest of Moslems, can be roused by their faith.

The *mullahs*, or doctors of theology, who have spent four years at Cairo or in the Seychelles, are practically the only learned men. Guided by them the Malay quarter of Cape Town thrives in a religious as well as material sense. Ramadan is strictly observed, and no representation of anything earthly, nothing more ornamental than a text from the Qur-án, is permitted to adorn the dwellings. From the slopes of the Lion Hill some eight small mosques, wedged in amongst the houses, overlook the mother city of South Africa. High up the slopes the *tun-er-ba-ru*, the graveyard, long since disused, marks the limit of the quarter.

In the Cape Province, in common with the other mixed non-European races and with natives, the Malay has the parliamentary franchise. In Cape Town a Malay, a doctor of medicine, takes his seat to-day in the City Council. As regards education the non-Europeans of South Africa are largely left to themselves, and the Malay has grasped the necessity for secular education. Schools appear soon after mosques. In every public gathering of school-children boys are seen in fezes and girls beribboned with the green of Islam. It is laughable to see the youth of a community parading a "guy" on the fifth of November, as if they were London children, and with as much idea of the event they celebrate.

Proud of their British citizenship, they are, however, Moslems first. Their weekly paper, *The Moslem Outlook*, printed in English, records every Moslem event, be it a meeting of the Khalifate Congress or a Riffi success in the Moroccan war. Gradually but inevitably they are approaching fusion with the other branch of Islam in South Africa, the ever-swelling Indian population.

No historian has told us fully the tale of the Cape Malays. No mark have they yet made upon the land of their captivity, save for the few words of their ancient tongue that Dutch children have absorbed from their slave-nurses into the *taal* of Dutch South Africans. As a self-respecting English-speaking community much may be expected of them in the future.

Correspondence.

SCIENCE AND FREEMASONRY.

To the Editor of DISCOVERY.

SIR,—I have read with interest Mr. Hugh B. C. Pollard's article "Bacon and his Legacy" in your May number, especially those parts of it which lay stress upon the debt owed by modern science to Bacon's advocacy of unprejudiced thinking. May I, however, beg leave to traverse certain errors in historical fact, and some inferences which affect conclusions that readers of the latter parts of his article might naturally draw? I refer to the evidence for a connexion between the organization of science and the organization of Rosicrucian and Masonic principles.

Joseph Glanvill, the well-known writer and defender of the early Royal Society, was not "Chaplain to James the First"; he was, about the year 1672, a chaplain to Charles II; he was not born until a dozen years after Bacon's death. Hence whatever he might state concerning Bacon's doings—though I am not at all sure that Glanvill's statement on p. 88 of "Plus Ultra" does refer to the actual founding of a society—cannot be from contemporary knowledge.

The account of the "Invisible College" is, I fear, unfortunately erroneous. Whether Robert Boyle was "largely influenced by Fludd's teachings" or not, he did not found the Invisible College. He joined it, in his twentieth year and before he began chemical work, within about a year of its being founded by a number of older men. I know of no evidence that the so-called college "was to be essentially a secret organization." It was simply a small club for experimenting in physical and biological science, and it met once a week in the house of one of its members, or in a room in certain taverns, and eventually in a part of the buildings of the forty-year-old Gresham College. (It is hardly just to the latter institution to say that "the society became public as the Gresham College"; nor, by the way, was "The Academy" a special name for it between 1660 and 1662.) The name given to the original club by its own members was "The Philosophical College," the word "College" having its older meaning of a society, retained in our "College of Cardinals." The nickname "Invisible College" appears first in a letter of Boyle's dated February 1647; here he seems to have made use of the then newly-transferred sense of the term "College," implying a building, in order to bring off a mild joke at the lack of a fixed habitat for the club. There was, at all events, no mysteriousness about it, as may be seen from the two accounts left by John Wallis, one of its founders; nor about its still more active offspring at Oxford in the sixteen-fifties.

Mr. Pollard suggests that "there is a very strong connexion between the early history of the colleges which eventually became the Royal Society and the early history of English Freemasonry." He has cited Wren, Ashmole, Locke, and Moray as being eminent not only as early Fellows of the Royal Society, but also as Freemasons. But of these four men only one—Wren—had been a force in the pre-Royal Society clubs, and then only in the second of these, namely, that at Oxford. There were many others, not mentioned in the article, who were the founders or mainstays of these clubs in London and in Oxford. Were Wilkins, Wallis, Goddard, Foster, Boyle, Petty, Ward, Bathurst, Glisson, Ent, Merrett, Scarbrough, Rooke—to name no more—Freemasons? If they were, Mr. Pollard's attractive thesis is strengthened considerably; if not, then the suggested connexion, so far as it depends upon the evidence printed in the article, would be of the vaguest.

I hope that, if I have ventured to correct some errors, I may also have given Mr. Pollard an opportunity for testing pretty conclusively the interesting hypothesis which he put forward.

I am, Sir,

Yours faithfully,

Durham, 2nd May, 1926. IRVINE MASSON.

The Story of Artificial Fertilizers.

By John B. Hyatt, B.Sc.

UNTIL the middle of the last century, the farmer's stock-in-trade had been the least pretentious of all industrial resources. The plough was mechanically the same simple implement as that which had turned the Phoenician furrow, the scythe so ancient as to be allegorical in the hands of Father Time. Even the farm-cart, primitive, if useful, might have graced the fields of Assyria with no disturbing sense of anachronism.

Defiance of Tradition.

This is, perhaps, not a matter for wonderment when we reflect that the practice of husbandry is the most ancient industry in the world. The surprising part of the affair really lies in the fact that a time should have occurred when science, quite suddenly, made a frantic, if tentative, move to push the farm into the noble company of industrial factories. To use a somewhat clumsy metaphor, the effect upon the farmer was to make him drop his oars, and slowly to haul up a sail in pursuit of the steamships of commerce. He is still sailing, but shortly he will install turbines.

The artificial fertilizer was one of the first scientific defiances of tradition. Farmyard manure was—and still is—the most elemental of agricultural necessities, although it is true that several other forms of fertilizer had been used sporadically for many generations, these mostly of a slow-acting nature.

Bones, feathers, wood-ashes, seaweed, wool-waste, and lime, all found their limited places in agricultural economy; yet with one exception their employment was so occasional and their net value to the farmer so comparatively low, that they scarcely deserve mention as competitors. The notable exception was lime.

Farmyard manure is the natural food of plants, but, unfortunately, is neither sufficiently quick-acting, nor available in large enough quantities to keep pace with the continual drain upon soil-resources involved in modern husbandry. Since the original break-away from tradition, therefore, science has gradually placed in the hands of the farmer a series of artificial foodstuffs which are designed to eke out his supply of farmyard manure.

Of those food-materials which, other than water, are normally derived by the plant from the soil, four only are liable to so-called "exhaustion." The term, however, is something of a misnomer, for cases of true soil-exhaustion are very rare. All root-absorbed plant-foods may be, and usually are, present in the soil in large quantities, even though—being insoluble—they cannot pass through the walls of the fine hairs which cover the absorbtive portion of a root.

Nitrogen in this unsatisfactory state is found in decaying plant-debris, and to a certain extent in farmyard manure. The phosphates of iron and aluminium are insoluble and constitute the major portion of an unmanured soil's store of phosphorus. Similarly, potash is "locked up" in zeolitic or impure clay, and chalk is too well-known for emphasis as a calcium compound which is insoluble in water.

It is this "unavailability" of plant-food which has been loosely termed "soil-exhaustion." Unavailability is a temporary state, for the soil must not be regarded merely as an inert mass of mineral matter. It is a vast chemical laboratory in which millions of micro-organisms are working diligently to convert complex and insoluble materials into a simpler form suitable for "digestion" by crops. These diminutive labourers, assisted by their larger colleagues—such as earthworms—and by natural inorganic weathering agents, are able to deal slowly with large quantities of such unavailable materials; but the process is not sufficiently rapid to keep pace with the intensive "soil-exhaustion" which results from an increasing human population.

Plant-Food.

The duty of an artificial fertilizer is either to supply plant-food in a soluble form, or else to convert pre-existing nutrients into such a form, wherein they are utilisable by the crop. The four elements mentioned previously in this article as subject to "exhaustion" are nitrogen, phosphorus, potash, and calcium. Plants absorb their nitrogen in the form of nitrate, and it is to this state that all nitrogenous fertilizers (artificial or otherwise) must eventually be converted. The normal forms in which nitrogen is *applied* to the soil are, firstly, sodium nitrate—the "Chile Nitre" of commerce, and, secondly, sulphate of ammonia, which is a by-product from gasworks, or is produced synthetically.

Other forms of nitrogenous artificials are occasionally used, of which the least common, though most interesting, is synthetic urea. A discussion of this fertilizer is particularly fascinating because it may be looked upon as a "link" between farmyard manure and its inorganic counterpart. Incidentally, it forms

the bridge crossed in 1828 by Wöhler, who connected thereby the hitherto distinct departments of inorganic and organic chemistry.* The animal produces urea in the liquid portion of farmyard manure by the breakdown of protein material assimilated from a plant. Scientists can build it up from lime, coke, nitrogen gas, and water.

The lime and coke are first heated to 3000° C.—a temperature which causes their chemical combination to form calcium carbide. The carbide is pulverized and further heated in a furnace through which is passed nitrogen gas obtained by the fractional distillation of liquid air. The result of this process is to form calcium cyanamide, a substance which is itself used as an artificial fertilizer. From this stage, a secret process employed in Germany performs the notable feat of converting a typically inorganic into a typically organic compound. The details of this system are complicated, but its academic basis lies in the treatment of calcium cyanamide with the elements of water.

The function of nitrogen to the plant is that of building up *protein*—a substance which has been mentioned previously, and which is very necessary to young growing animals. It is stored by the pasture-fed dairy-cow as a plentiful constituent of milk. The ocular effect of nitrogen upon a crop is to produce a luxuriant growth of foliage—and thus to encourage the formation of *carbohydrate*, an energy-producing material which relies for its building upon the action of sunlight falling upon the green leaf.

Root-Formation.

Phosphorus is associated largely with root-formation, and is thus a prime factor in extending anatomical facilities for the absorption of other foods. Its second function is to promote the early ripening of a crop. It is applied to the soil in various forms, such as bones, superphosphate, mineral phosphates, and basic slag, which latter is a by-product from steel manufactories. The earliest form in which the farmer made use of this food was that of bones, but the term "artificial" has to be stretched a little to include such typically direct animal-derivatives. Bones in their original state are seldom used nowadays, since the processes which they have to undergo in the soil are so prolonged that years must elapse before the phosphorus which they contain becomes sufficiently soluble for assimilation by the crop.

Superphosphate has been termed "The king of phosphatic fertilizers" because very nearly the whole of the phosphorus present in this substance exists in a readily available form. It is prepared by treating mineral phosphate with sulphuric acid.

Basic slag is a very useful fertilizer, but, owing to recent economic improvements in the manufacture of steel, the by-product nowadays contains very little *soluble* phosphate.

Potash is another chemical element associated with the formation of carbohydrates in the leaf. Plants are supplied with this substance in the form of the sulphate, chloride, nitrate, or carbonate (rarely) and various mineral resources are tapped to provide this fertilizer. In earlier days potassium carbonate used to be extracted from wood-ashes in vessels or "pots." Hence the name "pot-ash." The value of wood-ashes as a fertilizer has long been appreciated, and the application of bonfire-residues to flower-beds has for many years been a profitable occupation on the part of the gardener.

An Aid to Digestion.

Wood-ashes are, however, to-day seldom made use of in agricultural practice. Normal soils contain large quantities of insoluble potash, but such sources only become available to the plant under special conditions which may have to operate over a long period of time.

The chief function of *calcium* is not as a true plant-food, although its absorption in small quantities is essential to normal plant-growth. Its more important duty, in lime or chalk, is as an "aid to digestion," helping to render insoluble potash available for plant-nutrition. Lime is, in fact, an all-round tonic for the farmer's crops. It is a valuable deterrent against most fungoid pests, it provides a base for *nitrification* (the process whereby bacteria are able to simplify complex nitrogenous foods), it retains, or stores super-phosphate in the intermediate form of dicalcic phosphate, and it is largely instrumental in rendering plant-poisons harmless.

One of the most important uses of lime, from a practical point of view, is the *flocculating* effect which it exerts on a "heavy" clay soil. A really stiff field is an economic liability to the farmer, not only because he requires greater power to draw his cultivating implements, but also because such land is liable to work up into an impervious paste if stirred or trampled upon. In a case such as this, the field is badly drained, plant-roots are starved of air, and the liability to disease is great. The effect of lime is to cause the cohesion of finely-divided clay particles into larger fragments more nearly resembling the consistency of sand. As a result, the land becomes looser, better drained, and very much more easy to work.

* Wöhler obtained urea by heating ammonium cyanate.

Birds, Crops and Insects.

By H. H. Wardle, F.R.H.S.

Editor of "The Fruit Grower."

The controversial subject of bird-protection is of special interest in its bearing on agriculture. Birds damage crops, but they also control insects; and the relation of artificial measures to this balance involves many important considerations.

SOME truth is to be found in the oft-made statement that the farmer or fruit grower occasionally turns his hand against his best friends, but it is not true in the main that either of them is guilty of the indiscriminate slaughter of birds. Like other creatures, birds are not always "true to character," and most of them take toll in some shape or other of cultivated crops in the form of fruit and grain, while the superficial observer often takes note of the incidental damage done in the search for insects, and concludes that the activity of the species concerned is directed against his own interests, whereas the exact contrary is the case. On the other hand, keen bird protectors are apt to shut their eyes to certain facts and to emphasize others far too forcibly. When we have an object very much at heart there is a temptation not easy to resist to magnify what is seen or heard beyond its just proportion. So let us hold an unbiased opinion of what is taking place in respect of birds in their relation to food production and health, and what it means. The ardent bird protector declares that all birds are useful. The agriculturist and horticulturist thinks differently, although not to the same length. The game-preserver has a very one-sided "black list," and as a rule cares nothing about the rest. The economic biologist strives by scientific methods to get at the truth, but is sometimes misled.

Birds and Agriculture.

As knowledge progresses the part played by birds in the economy of agriculture and horticulture is more clearly seen. But definite and exact information is largely wanting, and what is established is not always available to those who ought to have it. For this reason attention may be drawn to a valuable book by Mr. E. M. Nicholson,* which as a record of man's relation to birds in these islands has perhaps no equal in the literature of the subject. "The economic aspect of birds," he says, "is the most important one from a practical point of view, and it deserves to be better understood by experts as well as by their audiences." The author has sifted and co-ordinated the available material on the subject to admirable purpose, and he puts his case for a newer form of protection or preservation that is diametrically different from the present with moderation yet with outspoken and unflinching conviction. The failure of what he calls scientific protection lies, according to Mr. Nicholson, either directly or indirectly in the over-protection of the small birds. Three reasons are given for the scarcity of big birds. One is the enmity of the "keeper"; another the greed of the collector of eggs and birds; the third the eagerness of the small bird lover to urge the destruction of raptorial birds. Gulls, rooks and starlings have been over-protected, and allowed to fill the gaps left by our destruction of the hawks. The balance is upset; and this zealot for protection would be content in certain circumstances to start with the wholesale destruction of the species that disturbs the natural equipoise.

* "Birds in England." By E. M. Nicholson. (Chapman & Hall. 12*s.* 6*d.*).

The Balance of Nature.

Under normal conditions all birds are of some use, but what are normal conditions? If by this we mean natural conditions we cannot attain to them, for we must cultivate, and immediately we do this we destroy natural balances and conditions. Man is not going to —because he cannot—return to the primitive in order to readjust the balances which, by his progress, have been dislocated. In the process of civilization we have forced the unnatural upon Nature because we, as well as birds and insects, to say nothing of the humbler plants we count as weeds, desire to live. The trouble is that the human has delegated to himself the right to adopt a utilitarian standard by which he measures the usefulness or destructiveness of all other forms of life. We shall continue to regard as injurious and therefore deserving of destruction or repression those living things which if allowed full play would hamper our existence or even destroy us; but we should proceed with caution, or we may, unwittingly, slay our best allies. Whether we argue this about birds or not, we may well consider whether the preservation of the economic status of birds is not worth while for all it means. One does not need to be familiar with the works of Darwin to understand how easily the balance of Nature may be upset with dire

results. As a friendly ally or a hostile force man is constantly exercising a direct influence upon the future of one species or another of the so-called lower orders in the general struggle for existence. The immediate result at which he aims is usually obvious enough, but it is not always so easy to estimate the indirect consequences of his somewhat arbitrary interferences with Nature's processes. These, when they at last declare themselves, are not infrequently found to produce unexpected results. And did not Nature step in again in an endeavour to adjust the balance we should have ultimate results that would be far from beneficial to mankind.

For while our methods may be wholesale and ruthless, those of Nature are inexorable. If for a series of years all the young of one species of beneficial bird—that is, a bird considered useful to agriculture and food production—survived and this continued for a few generations, any mathematician can estimate what would happen: the food supply of other living things would be consumed, other food supplies would be attacked, and in a few years the problem would cease to worry us—for the simple reason that we should not be here. Again, the fecundity of certain insect forms is astounding. A Canadian entomologist has determined that a single pair of Colorado beetles, without check, would multiply in one season to sixty million units.

The Control of Insects.

"That the land produces annually a vast number of insects which would ruin the crops if they were not promptly destroyed is admitted as common ground" is a statement made by Mr. Nicholson in his book, and no one will dispute it. Not only is his case, as already agreed, put with moderation, but with wisdom, and on the whole with the backing of sound and thorough information. It is, therefore, somewhat surprising to find Mr. Nicholson saying, on the subject of the menace to food crops by insects, "it is further agreed that at present the necessary destruction [of injurious insects] is performed almost entirely by birds." "Suppose," he continues, "some chemical or other means were discovered by which insect pests could all be kept under effective control, it would undoubtedly be costly. It is extremely improbable that it could be manufactured and distributed and used at a smaller cost than the amount of the damage inflicted by the birds." Agreed that it is so, and further that in any world that we can imagine it would be a dangerous experiment to destroy all the insects (if it could be done), it is not, however, possible to hold with the author that "there is no alternative to letting the insects be kept under control by birds." The situation now is that insects are not kept under effective control by birds. And is every insect an enemy? We should have little cross-fertilization without insects, and the bird does not stop to inquire if an insect it desires is useful or harmful to man. Provided it is not marked with certain colours which the bird interprets as "inedible" or "capable of retaliation," it is swallowed at once. In the undisturbed play of natural forces, which no longer obtains, it might be possible for birds to so serve the purpose of man in the conflict with insects that the cost and trouble of applying chemical means of control would have been spared the grower. But modern growing conditions of an intensive character are far too artificial to hope to secure immunity from insect pests through the agency of birds alone.

The Discovery Book Club.

THE *Discovery* Book Club is a co-operative effort to increase the supply of books available to readers. Every student is faced with the loss that always occurs in the haphazard disposal of his surplus books, and by bringing supply and demand into direct relation *Discovery* will benefit both buyer and seller.

All postal subscribers to *Discovery* are entitled to membership, and can open an account with the Book Club on the understanding that bills are payable quarterly. All trouble in remitting cash with each order will thus be avoided, as the Club will simply debit the buyer and credit the seller in the Club accounts. New books will be charged at the published price, post free; and second-hand books at the seller's price, plus sixpence for expenses.

All other regular readers of *Discovery* are also entitled to membership, but on the condition that every book is paid for in cash at the time of purchase.

In sending notices of books wanted and for sale a member should state that his name is already on the *Discovery* postal subscription list, or that he is a regular reader of *Discovery*, or should enclose one year's subscription to *Discovery*.

Members undertake in offering books for sale that these are in good condition. Damaged or defaced copies will not be entertained. In every case the price that the member is prepared to pay, or the lowest price that he will accept, should be stated. In pricing a second-hand book the figure should seldom be more than half the published price for a book in really good condition; if old, one quarter to one-fifth original price.

The Club having instructed one member to forward a book to another member requiring same, it will be deemed that after five days a contract has been made, unless within that period the book be returned as in an unsatisfactory condition and the Club notified accordingly. When a non-subscriber is informed that a book required is at his disposal, he will forward payment to the Club, which will then instruct the seller to dispatch the book to him. In every case cash will then be credited to the seller's account, and settlement will be made quarterly by the Club. If a book is returned as unsatisfactory, the Club will debit the purchaser with a charge of sixpence for expenses.

The Club reserves the absolute right to refuse business in such cases as it may deem desirable. A list of books wanted by members is published in the advertisement pages, and readers able to supply these are invited to communicate with *Discovery*.

Recent Developments in the Production of Optical Glass.*

By W. H. S. Chance, M.A., and W. M. Hampton, B.Sc.

At the third Optical Convention lately held in London both the variety of products exhibited and the wide field covered by the papers presented bore testimony to the remarkable progress made by British manufacturers, of which the following is a typical record.

THE business of glassmaking is one which may be classed as an "art" rather than a "science" and anyone who is, or has been, connected with it will agree that this is so; although its foundations are laid on scientific conceptions, it is greatly dependent for its results on the human element. The elimination of the liability to human error is undoubtedly an ideal to be aimed at but, as in other manufacturing processes in which it is necessary that the fusion of certain raw materials should take place at high temperature, the human element is still a vital factor, and not a few clever scientists have suffered disappointment when the vessel, which as a model floated so placidly in the calm of a laboratory, had to face the stormy seas of full-scale manufacture.

The manufacture of optical glass for telescopes and other scientific instruments was introduced by the firm of Chance Brothers in 1848, who had engaged the services of George Bontemps; from then up to the outbreak of war, they were the sole manufacturers of optical glass in the British Empire, and in 1914 were listing approximately twenty-six types which, with the exception of certain special varieties required only in limited quantities, were sufficient to supply the needs of the British scientific instrument trade.

Stimulus of the War.

The outbreak of war brought with it enormous and unprecedented demand by the navy, army and air force; during the first two years of the war this was for the more ordinary types such as flints and crowns, but towards the end of 1917 the problem presented itself of producing glasses for a very large number of photographic lenses required by the Air Board. These different types of lenses necessitated the production of a light barium crown, two light barium flints, two dense barium crowns and an extra light flint, the last three glasses of the most extreme properties. In the year 1918 the firm's production reached its maximum and an output of 235,000 lb. was achieved, which was equal to some four to five times the estimated pre-war world demand for optical glass. Since the war, production has been on a greatly reduced scale, partly owing to the liquidation of war stocks and partly to foreign competition, but with a range of approximately 112 varieties, and with quality which is admitted to be second to none, the needs of any optician can now be supplied.

*Abstract of a paper presented to the Optical Convention, London, 13th April, 1926.

Barium Crown Glass.

Every variety of optical glass presents difficulties in manufacture peculiar to itself, and of all types which it is possible to manufacture to-day the dense barium crowns are probably more difficult than any others. The invention of the F2 lens presupposed the possibility of obtaining a glass with a refractive index of 1.613 and with a V value ($n^D—1/n^F—n^C$) of 59.5. The special feature of the barium crown type is the replacement of a proportion of the silica used in ordinary borosilicate crowns by barium. This has the effect of yielding a high refractive index without greatly reducing the V value. It was known from small-scale experiment that it was possible to produce such a glass, but it remained to be seen whether it could be produced of optical quality and durability suitable for commercial use. Apart from such relatively minor points as difficulty in annealing and a tendency to devitrify, it was found very hard to produce a glass sufficiently free from "seed" (bubbles) and veins (striae). Dense barium crown glasses are peculiar in that they are extremely corrosive at high temperature and give off a large amount of gas in fusion; one constituent is at the same time relatively volatile. The first of these problems was minimized by the development of a special type of pot, capable of withstanding the solvent action of the "batch" (mixed materials) and the "metal" (molten glass), while the second was overcome by special methods of "founding," *i.e.*, conducting the process of fusion. It was realized at the outset that, to minimize changes in optical properties due to volatilization, it was vitally important to control as far as possible all the various operations of "founding." Previously, with the ordinary type of Siemens regenerative gas-fired furnace, temperature control left much to be desired; it was therefore decided to develop a new variety of

furnace which should be controllable to within plus or minus 5° C. at a temperature varying between 1200° C. and 1450° C. This new furnace has now been in operation for over three years, and has completely justified the time and care spent on its design and development. It may be of interest to state that the firm's present method of furnace control consists in marking a line on the chart of a Cambridge recording pyrometer attached to the furnace which has to be followed by the "teaser" (furnace man) in charge. Thus it is possible within the limits of human error to follow out a preconceived programme of "founding," and so at will either to repeat the heat treatment of a melting on almost exactly similar lines to those followed before, or to vary it as required. To show how successful this procedure has become, we might mention that before the installation of this furnace, the good glass produced from a series of pots of the same type might vary between nothing to as much as 20 per cent, whereas now not only have results become more consistent, but the average production of good glass per pot has considerably increased. Owing to the very corrosive nature of the batch, the amount of iron dissolved by the glass from the clay of the pot became a very serious factor, the resultant greenish colour of the glass at times being so pronounced as to cause several meltings to be scrapped, but vast improvement has now been effected both in colour and general quality.

Importance of Temperature.

The most important property of a glass in relation to its annealing is the variation of its viscosity with change of temperature. Mr. F. Twyman, F.R.S., in 1915 carried out investigations which for the first time pointed to the importance of a knowledge of the rate of release of stress at various temperatures and the variation of this rate with changes of temperature. The result of these experiments was a decided quickening up of the annealing process, with an important consequent saving of time at a period when output was an imperative consideration. He found that the rate of release of stress at constant temperature was proportionate to the stress present at any time. In 1919, Adams and Williamson, of the Geophysical Laboratory of America, showed that this is not strictly true; it is close enough, however, to give an insight into the physics of the process. Mr. Twyman also showed that the rate of release of stress doubles itself for a constant temperature interval, which averages about 8° C. This is known as Twyman's Law, but is again only true in so far as the change of viscosity with change of temperature follows an exponential law. It is, however, reasonably correct over a short range in the neighbourhood of what is somewhat arbitrarily known as the annealing temperature; in any case no alternative to this relation has yet been suggested. The scheme put forward was essentially that at present in use, namely, that the glass should be held at a suitable temperature—high enough for the strain to diminish to a small amount in a few minutes and yet not high enough for the glass to be distorted—and then cooled at a predetermined rate which could safely be increased as the temperature fell. At about 100° C. below the fixed temperature, the rate of cooling is governed only by the risk of fracture of the glass under the strain imposed by the temperature gradient, none of this temporary strain being present in the cold glass. This was an enormous advance in practice, and subsequent investigations have done no more than produce closer approximations of the still unknown laws governing the flow of so-called viscous bodies under stress, and discussions of the mathematical implications of the formula which Twyman deduced.

It is found that dense barium crown glasses change in viscosity more rapidly than other types of glass for a given temperature change. This necessitates much greater accuracy in temperature control with consequently increased difficulty in the annealing process. A further factor in the annealing of these glasses is the fact that, although for a given stress the birefringence or double refraction shown by these glasses is no greater than that shown by a dense flint, the accompanying absolute change of refractive index, which is more serious from the lens maker's point of view than the double refraction itself, is at least twenty times as great. Thus not only is dense barium crown more difficult to anneal to a given standard than other types, but the standard itself must be higher. The success attained in attempting to solve this difficult problem is indicated by the fact that lenses containing dense barium crown are produced by several makers which pass the most exacting tests as regards definition, and a disc has even been produced which has been worked to a lens of 15½ inches diameter for an astronomical objective from this type of glass. We believe that a lens of this size in a glass of such extreme properties is unique.

Coloured Glasses.

To turn now to the subject of coloured glasses; those made in sheet form are divided into two main varieties—pot metal and flashed—the former coloured throughout, and the latter having colour only in a thin skin spread over the main body of white glass. Prior

to the war the following colours were generally available: pot metals—yellow, blue, purple, green, signal green and yellow-green; flashed—ruby, blue and opal. Since the war a number of glasses which were previously made only in the "pot" form have been produced as "flashed," but as regards those suitable for optical purposes these can hardly be considered, owing to the inevitable variation in colour due to the uneven thickness of the "flash."

Coloured glasses may be divided into two classes: those that depend on a coloured silicate being present, and those depending for their colour on the uniform dispersion of particles of a constant size. Most of the former are comparatively easy to produce, but the latter depend on such factors as the atmospheric reducing or oxidizing conditions in the pot and furnace, the rate of cooling of the melt, and the temperature and time of annealing. Thus a mixture containing selenium may give a deep clear ruby on being rolled into thin sheets, but an opalescent brown glass on being pressed into disc, or an opaque black mass on being cooled in the pot in optical fashion. Also, owing to the necessity for making two or more "gatherings" to obtain sufficient metal to form a sheet, it may be impossible to blow the glass without opalescence, although under other methods of working it may be perfectly tractable. Thus the production of such glasses necessitates long research into all the conditions of mixing and making, and very elaborate control of the furnace and annealing before exact repetition can be secured.

Some two years ago it was decided to produce a range of glasses to replace the coloured gelatine filters previously used for isolating various portions of the spectrum, and a series of glasses is now marketed giving more sudden "cut offs" than were previously available. One of the principal advantages of a glass colour filter is its permanence, even in tropical countries. It is impossible for it to fade on exposure to light, and there is no risk of its melting when placed near a source of light.

Ultra-Violet Light.

A certain demand has arisen of late years for a glass which will transmit ultra-violet light while at the same time absorbing visible light. Professor Wood, of Johns Hopkins University, produced a glass with these properties some few years ago, and at the request of the Admiralty a similar glass has been brought out by our firm which has found a certain limited use in laboratories, and also in the theatre when it is desired to produce curious spectacular effects by ultra-violet light acting on certain substances which have the property of fluorescence.

The question of neutral glasses is one which has received and is receiving some attention, the chief difficulty being to produce any standard which may be generally agreed upon. The firm was successful in producing a series in which the neutral effect was obtained by the interaction of certain colouring oxides, but owing to the changes in colour brought about by varying degrees of "oxidation," it has been thought wise to attempt to reduce the number of colouring oxides in the "batch" so that a more colour-stable glass may result. Experiments are now being carried on with the co-operation of the British Scientific Instrument Research Association with this object in view, which it is hoped will eventually lead to a standardized series of glasses being placed at the disposition of the optician.

Spectacle Glass.

Prior to the war, practically the whole demand for spectacle glass was for the ordinary extra-white quality blown glass, which was supplied in the form of shapes cut to suit the needs of the lens grinder. Tinted glass of various shades was supplied to suit particular requirements, but nothing was produced in the way of glasses with special absorptive properties until it was considered to be of importance to produce spectacle glasses which should absorb the chemically powerful ultra-violet rays of the spectrum, which under some conditions are injurious to the eye. In 1912, a number of trial meltings were made, and some yellowish glasses produced effected the purpose. Soon afterwards, the late Sir William Crookes, F.R.S., as a member of the Commission appointed to investigate the causes and formation of cataract in certain industries, turned his attention to glasses which should absorb both the ultra-violet and infra-red rays, thereby subjecting the eye to the visible portion of the spectrum only. In collaboration with him our firm worked out mixtures to produce two types of special glass, the one colourless save for a faint bluish tinge, the other of a pleasant light neutral tint which, in addition to absorbing ultra-violet light, gave some general absorption of the visible rays.

The commercial production of these glasses was unavoidably postponed until after the war, but when they became available to the public the demand steadily increased, and to a considerable extent they have taken the place of the ordinary white glass previously in general use Experience has demonstrated the efficiency of these glasses, not only in hot climates, but even in sunless England, more particularly in cases where the wearer suffers from the all too common but not easily definable complaint of "weak eyes."

The Month's Wireless Developments.

WIRELESS TRANSMISSION OF PHOTOGRAPHS.

By F. H. Masters.

(*Editor of "The Electrician."*)

THE transmission of photographs by electrical means is a problem which has for many years had much attraction for inventors, and some solutions with a good deal of technical interest and embodying a chance of commercial success have been obtained. All these methods depend on the property that the electrical resistance of certain bodies, notably selenium, alters with the quantity of light to which they are exposed, in a similar way to that in which the electrical resistance of most bodies alters with the temperature. More recently attempts have been made to effect this transmission by wireless means. To do this it is obvious that interference from atmospherics must be reduced to the greatest possible extent and it is also necessary, if the system is to be used commercially, that it should be possible to repeat the signals received and to transmit them over ordinary telegraph circuits.

Curiously enough, during the past few weeks the details of two systems, by the use of which it is hoped to establish a service of photographic transmission on commercial lines, have both been made public. The first of these is the invention of Capt. R. H. Ranger of the Radio Corporation of America. This has actually been used for transmitting a number of photographs from New York to the main telegraph office of the Marconi Co. in London via the Riverhead Station on Long Island and Carnarvon. It is stated that the necessary receiving apparatus has also been installed in San Francisco.

As to the details of the Ranger apparatus, the photograph or document that is to be transmitted is copied either as a negative or a positive on to a transparent film of celluloid, which is mounted on the curved surface of a horizontal glass cylinder. A beam of light from a tungsten arc lamp is transmitted along the axis of this cylinder and reflected radially outwards through the film by means of a prism. A system of lenses is used so that the light only passes through a small portion of the film. The intensity of the light issuing from this film is obviously dependent on the density of the particular part of the image through which it is passed. This light is projected by a further system of lenses and mirrors on to a light-sensitive cell. The first system of lenses is moved backwards and forwards in a direction parallel to the axis of the cylinder, so that the amount of light falling on the cell will vary with the light and shade of a narrow strip of picture. The movement of the lens system is controlled by a tuning fork so that it is exactly synchronised with the moving part of the receiving apparatus. After each movement of the lens system the cylinder is rotated through a small angle, so that the picture is eventually transmitted in a series of parallel strips.

The light-sensitive cell is of the potassium hydride type, and the variations in its resistance cause corresponding variations in the plate circuit of a wireless valve. The plate current is supplied through a condenser, and when the potential of this condenser falls to a certain value, owing to the flow of the current through the valve, a relay comes into action. This relay operates a telegraph transmitting apparatus so that the picture is transmitted in a series of dots and dashes, the former corresponding to the light and the latter to the dark parts of the picture.

The Receiving Apparatus

At the receiving end the signals after amplification are employed to operate a siphon recorder. This is mounted on a travelling carriage, which is operated by a tuning fork controlled motor, so that it is in exact synchronism with the carriage at the transmitting end. The paper is moved forward after each stroke of the carriage so that an exact reproduction of the picture is obtained. The transmission of a photograph of quarter-plate size by this method takes about fifteen minutes.

The other apparatus, to which reference has been made, is due to Mr. T. Thorne Baker, an inventor who has been for many years working on the subject. I understand that the author himself has written an article for publication in *Discovery*, but the general system that is followed may be indicated here.

The picture that is to be transmitted is printed as a negative on a sheet of copper by a process similar to that employed in the production of half-tone blocks, but a screen ruled with parallel lines in one direction only is employed. The result is a picture formed of broad lines in the dark part of the negative and of narrow lines in the light part. This copper foil is wrapped round the cylinder of the transmitting instrument and an electrical circuit is made between it and the steel point mentioned above. This circuit is made and broken as the point passes over the lines

which form the picture and the insulating emulsion between them. A series of signals, varying in duration with the light and shade of the picture, is therefore sent out either by wireless or over a land line.

At the receiving end the signals are detected and amplified and are then passed through the receiving instrument, on which a sheet of moist paper treated with potassium iodide and starch takes the place of the copper foil. The steel point is replaced by a fine platinum style. When the current passes a series of dots are formed on the paper and give a picture of a brownish tint and of reasonably permanent character. The time taken to transmit a picture 5 in. by 4 in. is about six minutes.

Inventions such as these are of much scientific interest, while it is announced that a service of pictorial transmission will shortly be started on a commercial scale by the Marconi Co.

THE LANGUAGE BARRIER.

By Edward Liveing, M.A.

(Manchester Station Director, British Broadcasting Company).

It used to be said that the drilling of a railway tunnel under the Channel would have the effect of broadening the narrow insularity of the average British mind. The Channel tunnel has not materialized, but in broadcasting we already have an agent for the promotion of international understanding far greater and more potent than railway trucks labelled "Hommes 40, Chevaux 10," or than the luxurious cars marked as belonging to the "Compagnie Internationale des Wagons-lits." For a long time past continental wireless programmes have been available to the users of good valve sets, but the movement now is to link up Europe, so to speak, even for the crystal set users.

Much has been done in this direction by the Bureau International de Radiophonie at Geneva, in the inauguration of which British broadcasting played a very prominent part. Much of the work hitherto done by this Bureau has been of a technical nature relating to the regulation of European wave-lengths, but the Bureau has already become an important adjunct to the League of Nations, and played its part in the relaying and broadcasting of the speeches at the last conference of the League of Nations throughout Europe. British listeners will remember hearing the speeches of Sir Austen Chamberlain and other delegates on that occasion.

The British Broadcasting Company has for some time past been transmitting programmes to Europe through its high-power station at Daventry. These broadcasts are being continued during the spring and summer months until July, on Tuesday evenings at 6.30 p.m. From time to time, too, continental programmes are re-transmitted through the company's receiving station at Keston, which is connected by land lines to the simultaneous board in the London headquarters, whence the programmes are re-transmitted through a number of the British stations. No doubt much remains to be done to ensure perfection in these transmissions, but already enough has been accomplished to show that good transmissions can be effected. Another high-power station of 25 kilowatts has now taken the air. This is the station of Hilversum in Holland, and listeners will be interested to know that arrangements have been made for a regular interchange of British and Dutch programmes through the Daventry and Hilversum stations respectively.

A Problem of the Future.

These new developments bring to the forefront the problem of language. The claims of English, French, Spanish, German, and so forth, and of the artificial language Esperanto have at times been advocated but it is very improbable that artificial stimulation would have the effect of imposing an international language on listeners throughout the world. What may happen within the next century it is impossible to prophesy: a gradual conglomeration of languages, or the forging to the forefront of one or two languages extensively used, or highly expressive, or possessing a highly intelligible pronunciation?

One thing, I think, we may be sure of, and that is that future generations will begin to speak more foreign languages than hitherto. Courses in foreign languages are being given from many of the large broadcasting stations on the Continent, while a series of "French Talks," given under the auspices of the Institut Français by M. Stéphan, has been broadcast for some time past through British stations, and a new series of "Spanish Talks" is now being given at 7.40 p.m. by Mr. W. F. Bletcher from the Manchester Station, these being also relayed and broadcast through the Daventry high-power station. The talks of both M. Stéphan and Mr. W. F. Bletcher are wonderfully lucid and delivered by men who know how to amuse and instruct at the same time. One often wonders whether the many country dwellers to whom they are available through the Daventry station have begun to take up the study of these two languages. We should not under estimate the interests and mental abilities of the man behind the plough. Broadcasting has already shown us that this is a mistake.

Book Reviews.

Animals of Land and Sea. By AUSTIN H. CLARK, Smithsonian Institution. (Chapman & Hall Ltd. 15*s.*)

It is difficult to understand why this book is reproduced in an English edition. It deals with more or less the same range of subjects as does Mr. Borradaile's "The Animal and its Environment"; but Mr. Borradaile is extremely complete and accurate, and Mr. Austin Clark leaves something to be desired in both these respects. On page 59 our author states that very few beetles are parasitic; but surely this is hardly so. A recent article in *Science Progress*, p. 652 (April, 1926), states parasitism is the case in parasitic beetles of the family Staphylinidae—devil's coach-horses—one of the most extensive of the group Coleoptera, and in many other insects. The last-named family includes more than 13,000 species, usually small and inconspicuous. The larvae are usually somewhat like the well-known silver fish and in one genus, *Aleochara*, the newly-hatched larva gnaws its way into the pupa of certain Diptera, or true flies. It then undergoes a metamorphosis and changes into a cylindrical grub which is less active than its forerunner, and shows many obvious traces of degeneration. Many of the family Rhipophoridae have larvae which are parasitic upon other insects. *Metoecus* is common in wasps' nests. Its newly-hatched larva, which is black in colour, emerges from the eggs which have been laid on old wood and may be conveyed to the wasps' nest by the active wasp imago. It burrows its way into the body of the wasp larva and gradually devours the whole soft tissues of its host. It then penetrates into the 'cell' in which its victim lives, and as many as twenty or more may be taken from a single nest. Other species of the same family attack other wasps. *Symbius* is an endo-parasite of the so-called 'black beetles,' though they are neither black nor are they beetles. The female retains her larval shape, and is without wings. It passes its whole life in the body of its host. Of course, it all depends on what you mean by "very few," but for a naturally free-living group like the Insecta, beetles make a pretty "good show" as parasites.

Italian fleas are commonly assumed to be fleas *par excellence*, though some maintain that the Californian flea is superior. It certainly holds the record for the long and the high jump. But the author speaks of a flea about a quarter of an inch in length living on field mice. Like the Executive of the United States Government, this awe-inspiring insect is confined to the District of Colombia.

One of the bot-flies is described as living on the gums of crocodiles, and it is the welcome business of the crocodile birds to pick these off the gums—but surely what they remove is a leech or a fragment of flesh (for a crocodile cannot use a tooth-pick), and not a bot-fly.

Brachiapods, Polyzoans and Phoronids are said to be related —a very doubtful affinity. On the same page the Quahogs, or hard-shelled clams, are mentioned. I am not sure that a British naturalist would recognize a quahog when he saw one.

There are all sorts of American names for insects which the ordinary European will hardly understand. The "mourning cloak" which chirps, and "sometimes fly directly at you"—but this does not help us to know what a "mourning cloak" is. Later we are told that "flickers devour ants." There is no distinction between the robin of the new world and the robin of the old world, though we suspect that the writer is referring to the new world species. The road-runner is described as a "curious cuckoo" which feeds extensively on lizards; and we find that the everglade kite and the "limpkin" live on molluscs.

Various molluscs are mentioned under the names of killifish, cunners, scup, tautog, squeteague and flounders and cod are said to be fond of these curious univalves and bivalves. I doubt if any self-respecting European flounders or cod would consume molluscs with such names.

One of the fidgeting features of this book is that there is a total divorce between the text and the figures. The latter are numerous and on the whole well executed; but it is irritating to find that the articles on sea animals are illustrated by land animals, such as centipedes, scale insects, and the like, and it is still more irritating to find the legends of the text-figures all relegated to the preliminary matter under Roman figures. This means a constant turning of the pages.

A. E. S.

The Report of the National Physical Laboratory for the Year 1925. (H.M. Stationery Office. 8*s.* 6*d.*).

This report follows the lines of previous reports in summarizing the main activities of the many departments of this active, progressive, and useful semi-government institution. Part of the work done has been simply to advance scientific knowledge, part to solve technical problems, the solution of which is required by the public at large or by a government department or by a private firm. Much routine work such as the standardization of thermometers and barometers has also been done.

Some of the subjects investigated during the year at the laboratory are: the scattering of gamma rays from radium by matter, the measurement of the intensity of sounds, a comparison of the merits of the different insulating materials employed in standard electrical instruments, and the best way of earthing electrical circuits. Research in the photometry section has related mainly to the use of the photo-electric cell in place of the eye for comparing light intensities from different sources; as a method of colour matching the cell has been found, in suitable circumstances, to be ten times more accurate than the eye.

People who love accuracy and sigh when they fear that the British standard of length—the yard—is possibly wrong by one part in a million, may be assured that all is well. The Board of Trade unit of electrical resistance is between 99.99 and 100 per cent of the correct resistance. During the year the German and the British standards were compared and the difference, if difference there be, is not more than two parts in a hundred thousand.

Numerous researches on metallurgical subjects, wireless transmission, and on serodynamics are also summarized and illustrated.

A. S. R.

The Migration of Symbols. By DONALD A. MACKENZIE. (Kegan Paul, Trench, Trubner & Co., Ltd. 12*s.* 6*d.*).

Mr. Mackenzie is among those anthropologists who, under the leadership of Professor G. Elliot Smith, adhere to the "Diffusionist" rather than to the Evolutionary school, and seek to prove that all human culture was broadcast from one single area, Egypt for preference, rather than that it arose spontaneously in several areas. This volume is an attempt to justify that hypothesis so far as symbols like the swastika and the spiral are concerned, insisting upon their diffusion from Mediterranean centres over the entire globe. Had the theory

been presented with neatness and lucidity, and had Mr. Mackenzie marshalled his arguments in logical order, they might have carried more conviction. But they are wanting in clarity, and the instances by which he illustrates them are huddled together at haphazard, instead of being introduced in their proper sequence.

So far as his argument is concerned with the spiral, he believes that the whorled shell appealed to early man as a symbolic "cave" or "womb," a source of life. Shells were, to him, miniature caves, and in the caverns proper, life-giving winds were supposed to have their origin. Shells would, therefore, be regarded as life-giving and birth-assisting fetishes. From this arose the belief that all agencies having a circular motion—the sea, the stars, "whirlpool lakes," and so forth—appealed to early man as life-givers or controllers. So far as it is possible to argue such a thesis on data the most involved and difficult of elucidation, Mr. Mackenzie makes out a fairly reasonable if rather too ingenious case, but when he extends his theory to all whorled things, such as ears and vegetation, the analogy breaks down.

The book, if interesting as the work of a vivacious mind, is too labyrinthine and confused, and much too dogmatic in spirit. It is the weakness of this school that it seeks to cram its theories down the reader's throat rather than to nourish him in any reasonable way, and it is much too impatient of its adversaries. Unbiassed people will continue to believe that both Diffusionists and Evolutionists have something to offer them, and that if some symbols and beliefs were diffused by migration, others had their origin in more than one region of human activity.

Some Questions of Musical Theory. By WILFRID PERRETT, B.A., Ph.D. (W. Heffer & Sons Ltd. *7s. 6d.*).

It is natural that the more intimate sub-division of the octave should be engaging the attention of the advanced musician of to-day. In the seventeenth century, however, the matter was very much discussed, sometimes from the purely musical, and occasionally from the more mathematical point of view. Christopher Simpson in his "Compendium of Practical Musick" (1667), gives a diagram to show how those who used them endeavoured to indicate in the scores the small intervals in the structure of the octave. The sign for the semitone is the usual sharp sign of double crossed lines, and for the respective quarter-tones single or triple lines are employed. Dr. Perrett, in his prefatory remarks to his work of two chapters—(I) "How Olympos found his New Scale" and (II) "The Olympion," suggests the possibility that "the musical world of to-day is not so convinced of the superiority of modern art as it was in the middle of the eighteenth century," and that some of the composers may not be disinclined to "consider the melodic and harmonic possibilities of his new-old scale, and will welcome a new effect in 'solemn musick.'" In the new staff notation employed in the application of his theory there are no "accidentals," no sharps or flats, naturals, double flats or double sharps, but the digitals of the Olympion to be touched are shown by three types of notehead. The oval or ellipse indicates the white digital; the rectangular triangle (with acknowledgments and homage to Pythagoras) on the same line or space always stands for the next black digital up the scale, *i.e.*, the one immediately to the right; the St. Andrew's Cross, an old sign for a simple diesis, or "quarter tone" is used for the two russet-brown digitals representing two named notes which come between E and F and B and C respectively on our present keyboard. This idea forms part of his very abstruse discussion of that difficult and controversial subject, Greek music, which was in its day, as it is now, studied as a subject of mathematical and scientific inquiry. And to appreciate his "fine points" the reader will have to be a scientifically-minded musician or layman, something of a Greek scholar, and an expert mathematician into the bargain. It is doubtful if the work will appeal to the ordinary musician. As a class musicians are never likely to be mathematicians. The very nature of their activities and their habit of thought are opposed to the mathematical frame of mind; furthermore, they are never likely to go to the expense of acquiring the "Olympion" instrument in order to submit the "new effect in 'solemn musick'" to the practical test. Nevertheless, in taking the author's word for it, we can congratulate him on the conspicuous ability with which he has handled the problem, and can commend to the notice of all competent *cognoscenti* a book that stands as a monument of patient work and hard thinking—and provides the reader with plenty of opportunities for both. It is a difficult book, not least because it bristles with mathematical formulae that come only within the scope of the musician with a scientific bent.

H. H. W.

Comparative Physiology. By LANCELOT T. HOGBEN, M.A., D.Sc. (Sidgwick & Jackson Ltd. *7s. 6d.*).

This is distinctly a book of the younger and more progressive generation. The book is built for the double purpose of giving the science student specializing in zoology a little physiology, and the medical student who knows something about physiology some grasp of its application to the realm of the pure science worker who deals with the experimental material of the lower animals.

The book is divided into four main sections: Response, the Manifestation of Vital Activity, Metabolism—the source of vital energy Co-ordination—the Integration of Vital Activities, Reproduction—the building up of a new Animate Unit. These section headings give a clue of the author's treatment of his subject. He thinks of physiology with an eye to the interpretation of behaviour by physico-chemical laws rather than by psychological speculation.

It is essentially a technical book, but it is a thoroughly modern stimulating work likely to set the younger men at work in new fields of research. Excellent guides to further reading are included in every chapter.

Commonsense and its Cultivation. By DR. HAMBURY HANKIN, M.A. Foreword by DR. C. S. MYERS, F.R.S. (Kegan Paul, Trench, Trubner & Co. Ltd. *7s. 6d.*).

This is a curious book containing a wonderful array of anecdotes showing how intuitive processes are worked out by the subconscious mind. The chapter devoted to calculating prodigies is perhaps the most interesting. It will be useful to the popular lecturer on psychology as a quarry for material, although some of the author's conclusions will not pass without criticism.

Organic Chemistry. By JOHN WADE, D.Sc. Revised by HENRY STEPHEN, D.Sc., O.B.E. (George Allen & Unwin Ltd. *8s. 6d.*).

The third edition of this standard book by the late Dr. Wade has been revised and brought up-to-date by Dr. Stephen, of Manchester University. He has added a new chapter on the pyrone, chromone and xanthone derivatives, including natural colouring matters. The book is suitable for pass degree students.

H. B. C. P.

Casandras, or the Future of the British Empire. By F. C. S. SCHILLER. (Kegan Paul, Trench, Trubner & Co. *2s. 6d.*).

A little donnish pessimism fails to make our flesh creep as goosily as the author hoped. The British Empire is, in his opinion, doomed to crash because the Dominions view occasional European warfare with a prejudiced eye. The author views the development of a world-state dominated by financial considerations centred in New York, and proclaims that in such a state we should be a secondary interest. At Oxford, it seems, they detect a tendency for our Dominions to prefer American methods. A little travel might reveal unsuspected soundness in the poor old Empire.

The House of Health. By SIR JOHN ROBERTSON, C.M.G. O.B.E., M.D. (Faber & Gwyer, Ltd. *2s. 6d.*).

An excellent ittle handbook on the problem of the healthier working-class dwelling. The housing of the workers is more than a political problem, and if physical fitness as a nation is to be achieved, light, air and sanitation are necessary. The book is well worth reading by anyone interested either in the social problem or in planning the development of property. It is a sound and practical volume which throws light on the practical needs of housing schemes.

Tables and Charts giving values of Xn. By A. D. BROWNE, M.A., A.M.I.C.E. (W. Heffer & Sons, Ltd. *1s. 6d.*)

Anything which reduces the labour of computations is useful. This little book will be valued by workers, and is admirably suited to a wide range of uses where an adequacy of accuracy of some two per cent is sufficient. It is simple and very quick to use.

My Crowded Solitude. By JACK MCLAREN. (T. Fisher Unwin, Ltd. *12s. 6d.*).

This is a very charming book and will be widely appreciated The author spent eight years on a pioneer coconut plantation at Cape York in unknown North Australia. There he came into intimate contact with the Australian natives, and it is in the telling of his simple adventures with them that he attains his success. He has the gift of easy style, and you feel that you know these delightful savages. He writes with deep and kindly insight into the odd working of the primitive mind, and the book therefore becomes not a simple travel book or the usual potboiler by some photographer or artist who has toured in the Pacific, but a work of genuine anthropological interest, the result of years of close observation being well expressed.

H. B. C. P.

Books Received.

The Discovery of Intelligence. By JOSEPH K. HART. (George Allen & Unwin Ltd. *10s.*).

The Science of Flight. By CAPT. P. H. SUMNER. (Crosby, Lockwood & Son. *16s.*).

Chemistry in Modern Life. By SVANTE ARRHENIUS, Ph.D., M.D., D.Sc., LL.D. Translated by C. S. LEONARD, Ph.D. (Chapman & Hall Ltd. *15s.*).

Foundations of the Universe. By M. LUCKIESH. (Chapman & Hall Ltd. *15s.*).

The Language and Thought of the Child. By JEAN PIAGET. (Kegan Paul. *10s. 6d.*).

Scott's Polar Journey and the Weather. By G. C. SIMPSON, F.R.S. (Oxford University Press. *2s. 6d.*).

Psyche. No. 24. April, 1926. (Kegan Paul. *5s.*).

Stainless Iron and Steel. By J. H. G. MONYPENNY, F.Inst.P. (Chapman & Hall Ltd. *21s.*).

Prehistoric Man and the Cambridge Gravels. By THE REV. FREDERICK SMITH. (W. Heffer & Sons Ltd. *7s. 6d.*).

Second Report of the Adhesives Research Committee. (H.M. Stationery Office. *3s.*).

Notes on Geological Map-Reading. By ALFRED HARKER. Second edition. (W. Heffer & Sons Ltd. *3s. 6d.*).

The Natural History of Wicken Fen. April, 1926. (Bowes & Bowes. *5s.*).

Bulletin de la Section Scientifique. By DR. GR. ANTIPA. Nos. 1 and 2. (Académie Roumaine).

British Spiders: Their Haunts and Habits. By THEODORE H. SAVORY. (Oxford University Press. *6s.*).

The Australian Journal of Experimental Biology and Medical Science. Vol. III. Part 1. (University of Adelaide. Quarterly. £1 *1s.* per annum).

The House-Fly. By MAJOR E. E. AUSTEN, D.S.O. (British Museum: Natural History. *1s.*).

The Nervous Mechanism of Plants. By SIR JAGADIS CHUNDER ROSE, F.R.S., M.A., D.Sc., LL.D., etc. (Longmans, Green & Co. Ltd. *16s.*).

Exploring England. By CHARLES S. BAYNE. (Jarrolds Publishers (London) Ltd. *7s. 6d.*).

Race and History. By EUGÈNE PITTARD. (Kegan Paul. *21s.*).

Ouroborus, or the Mechanical Extension of Mankind. By GARET GARRETT. (Kegan Paul. *2s. 6d.*).

The Stream of Life. By JULIAN S. HUXLEY. (Watts & Co. *1s.*)

The Religion of an Artist. By THE HON. JOHN COLLIER. (Watts & Co. *1s.*).

The "Eotvos" Torsion Balance. (L. Oertling Ltd. £1 *1s.*).

Comparative Philosophy. By PAUL MASSON-OURSEL. (Kegan Paul. *10s. 6d.*).

The British Journal of Radiology. Vol. XXII. No. 87. April, 1926. (Percy Lund, Humphries & Co. Ltd. *5s.*).

The Case against Evolution. By G. B. O'TOOLE, Ph.D., S.T.D. (Macmillan & Co. *7s. 6d.*).

The Importance of Diet in Relation to Health. (George Routledge & Sons Ltd. *3s. 6d.*).

A Manual of Radioactivity. By GEORGE HEVESEY, Ph.D., and FRITZ PANETH, Ph.D. Translated by ROBERT W. LAWSON, D.Sc., F.Inst.P. (Oxford University Press. *15s.*).

Macedonia, Thrace and Illyria. By STANLEY CASSON, M.A. (Oxford University Press. *21s.*).

Religion and Folklore of Northern India. By WILLIAM CROOKE, C.I.E. (Oxford University Press. *21s.*).

Practical Ultra-Violet Light Therapy. By T. CLYDE MACKENZIE, M.B., M.R.C.S.(Eng.) and A. A. KING. (Ernest Benn Ltd. *6s.*).

"Scientia." Vol. XXXIX. N. CLXVIII-4.

The Elements of Chemistry. By WM. FOSTER, A.M., Ph.D. (D. Van Nostrand Co., New York).

Gyromagnetic Electrons and a classical theory of Atomic Structure and Radiation. By LOUIS VESSOT KING, F.R.S. (The Mercury Press, Montreal).

Psycho-Analysis for Normal People. By GERALDINE COSTER, (Oxford University Press. *2s. 6d.*).

Researches in Ecology. By FREDERICK E. CLEMENTS. (Carnegie Institution of Washington).

Modern Sunlight. Vol. 1. No. 3. May, 1926. (The Sunlight Bureau. *2s.*).

ROWNE,
.)
s useful.
mirably
ccuracy
y quick

Unwin,

eciated
ntation
e came
it is in
attains
hat you
l kindly
and the
e usual
d in the
est, the
ed.
C. P.

21s.).
GARET

D. 1s.)
(Watts

s.).
(Kegan

April,

S.T.D.

utledge

D., and
AWSON,

, M.A.

ROOKE,

KENZIE,
Benn

Ph.D.

ructure
(The

OSTER,

arnegie

unlight